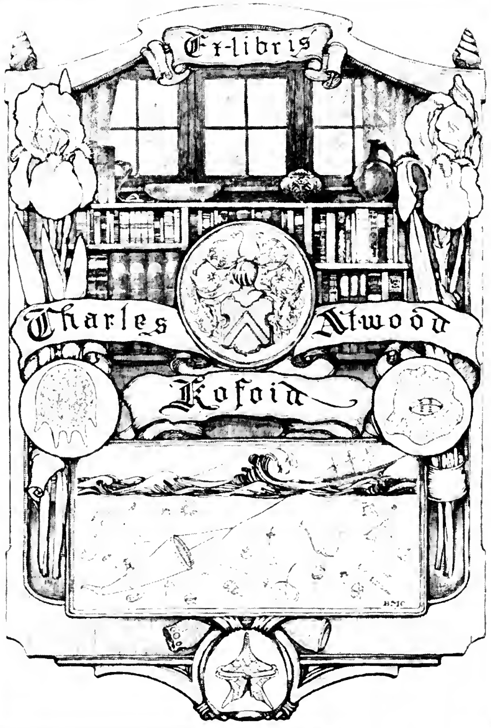
EPIDEMICS PLAGUES & FEVERS

THEIR CAUSES AND PREVENTION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BY

THE HON. ROLLO RUSSELL.

LONDON: EDWARD STANFORD,

26 & 27 COCKSPUR STREET, CHARING CROSS, S.W.

1892.

"It is in the power of man to cause the parasitic maladies to disappear from the surface of the globe, if, as I am convinced, the doctrine of spontaneous generation is a chimaera."—PASTEUR.

"Of the 627 registration districts of England, one only had an entire escape from diseases which in whole or in part were prevalent in all the others in the ten years from 1851 to 1860. . . . It was the district of the Scilly Isles, to which it was improbable contagion should come from without. In all the ten years it had not a single death by measles, by small-pox, by scarlet fever. It was one of the seven districts of England in which no death from diphtheria occurred."—JOHN SIMON.

"You, and not the 'Visitation of God,' are the cause of epidemics; and of you, now that you are once fairly warned of your responsibility, will your brother's blood be required."—CHARLES KINGSLEY.

"From the day when I first began to think of these subjects, I have never had a doubt that the specific cause of contagious fevers must be living organisms."—DR. WILLIAM BUDD.

"The one essential condition is cleanliness. That local sanitary authorities, proceeding to act upon this principle, with a clear intelligence of what cleanliness actually means, and with sincere resolution to enforce it in their respective districts, can within a few years reduce by some tens of thousands the annual mortality of England, is, I think, at least as certain as that such ought to be the aim of their existence."—JOHN SIMON. "The Prevention of Filth Diseases." *Local Government Board Report.*

"The most pressing work of sanitary reformers is now not so much to legislate as to educate; to make the mass of the people, in some degree, participators in the knowledge of the causes of disease which is possessed by men of science."—*The Times*, Aug. 11, 1891.

"As in times of invasion every loyal citizen is ready to take up arms in defence of the common liberty, so should every one make war against the common enemy which comes to attack the health."—F. MONTIZAMBERT, M.D., Superintendent Canadian Quarantine Service.

"Instruct your mayor and corporation, your clergy of all denominations, your own household, that every case of typhoid fever, of scarlatina, of diphtheria, of small-pox, measles, whooping-cough, can no longer be looked upon as natural, providential, or unavoidable, but that the existence of such preventable diseases is a proof of ignorance or negligence, and a disgrace to the country, to the town, to the family."—SIR SPENCER WELLS.

PREFACE.

The present volume is intended as an epitome of existing knowledge concerning the nature and prevention of maladies commonly spoken of as "preventable," and now chiefly under the legal control of local representative bodies. A handbook of this kind may be of service to all who are interested or officially concerned in the promotion of health, as members of local sanitary committees, school-managers, employers of labour, and others on whom the health of large numbers to some extent depends, and to whom it is important to be able to consult high authorities without loss of time, on subjects which are often difficult of access, or inconveniently scattered, or obscured by technical language. The results of researches gathered in this volume will be found to compose a foundation of principles for a very complete system of practical hygienic science. The author is keenly sensible of the many faults and deficiencies of the book, but hopes that the value of the results collected may render them comparatively insignificant.

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INTRODUCTORY.

A NEW and brighter prospect for the wealth of nations, using this term in its old and best sense, has been opened up in the last thirty years by the investigation of the causes and nature of communicable disease. Discovery and knowledge are now so far ahead of practice in Public Life-saving that we may confidently affirm that if society, that is, if nations and individuals represented in administrative power by the State, were to fulfil the known principles of prevention, more than half of human bodily suffering, and the mental suffering belonging to it, would ere long be stopped. The national will has to be bodied forth in responsive activity throughout the system in order that spreading diseases, and others partly within the field of corporate regulation, such as those arising from excessive facilities of alcoholic indulgence, may be reduced and extinguished. But the practical power of the engines of extermination which science with unsurpassed sagacity and ever-memorable labour has brought to the feet of law, can only work with efficiency and ease through the widest diffusion of sound instruction. National instruction is an essential part of the campaign. The principles of saving health, physical, mental, moral, ought never long to remain the property of the few, but to be diffused and impressed with authority on young and old throughout the country. While we teach the children of England in compulsorily-attended schools the names of ancient and unworthy kings, or of rivers in South America, or of lakes and mountains in Asia, we still omit to teach in public or private schools, to the young or to adults, many of the weightier matters which closely concern life, health, prosperity, happiness; we make no provision that before great responsibilities begin, the foundations of well-being, and the first duties of citizenship should be impressed on the mind, and wrought into the consciousness of the growing generation. Primary duties to the State, the city, the family, of a kind which is only realized through competent instruction, are left to be taken up haphazard, or to be learnt only through calamity, or to be ignored.

An educated voter may know enough to condemn the political rule of old Mesopotamia, or the follies of the Dark Ages, but he may nevertheless vote for a Town Councillor who builds pestiferous dens where fever always lodges, and who cares nothing for the powers we possess for the security of the people. But one who is acquainted with some of the main principles of science in relation to civic life, as they may be taught to all, will be likely, if he exercises his functions, to give weight in choosing a representative to a candidate's character as an honest and vigorous enemy of all that drags down the multitude into the mire of despond. The multitude itself would be raised by nothing more than by a scientific, that is by a true view of the world they live in and of their own powers of amelioration. When it is generally recognized what results may be brought about by forces organized in the light of reason, and with what facility much disease of the worst sort, and even much vice which flourishes in low physical conditions, can be removed, and when true doctrines of wholeness are well and wisely taught, and associated with individual responsibility in every action touching local, corporate, or general interests, we may look for a great shrinking in the dark waters which now cast upon hospital, prison, and poorhouse many a painful witness to public default. The work of reformers of recent times may well inspire the humblest with confidence that the gentle forces of light and hope are together mighty for human advancement.

NATURE OF SPREADING DISEASES IN PLANTS AND ANIMALS.

Before proceeding to the consideration of human disease, it will be useful briefly to notice some of the most destructive diseases in plants and animals. It will not be foreign to the subject to take as a first example a parasitic growth on non-living timber, that familiar cause of destruction to wood known as Dry-rot, a serious cause of decay in damp houses.

Dry-rot is the ravage of a kind of fungus known as *Merulius lacrymans*, of which the spores, when they fall on suitable soil, germinate, giving rise to a mycelium of cobweb-like threads. These spread and penetrate the substance of the wood, exerting a chemical action. The fungus seeks the light when about to produce spores, drops of liquid are exuded, the sporangia then dry up and discharge innumerable spores.

This fungus occurs almost exclusively in the wood of conifers; it is never seen in forests, and most affects improperly seasoned wood. Seasoned timber kept in well-ventilated places will not rot, and the timber of trees felled in winter is least liable to infection. The rot requires moisture and darkness for its growth, and the fungus is killed by complete dessication. Basements which are well-ventilated and dry remain free from the disease.

Thus a particular kind of wood, not well seasoned, a dark, damp, and ill-ventilated situation, and the presence of a particular fungus-spore or microbe, are required for the development of the Rot.

Even more instructive as illustrating the action of many diseases in living creatures are the discoveries which have made us familiar with the process of fermentation, and the growth of the yeast-organism in certain liquids which afford appropriate nourishment. Yeast belongs to the family of the *Saccharomycetes*, and is destitute of mycelium. It multiplies by buds and spores like all the elementary fungi (Schutzenberger). The most favourable temperature is from 25° to 35° C. (77° to 95° F.); it is inactive below 9° C. (49·° 6 F.) and above 60° C. (140° F.), the temperature at which albuminoid principles begin to coagulate. The most favourable form of yeast-food comprises three groups, carbohydrates, proteids, and mineral matter. If yeast be added to a solution of sugar, fermentation begins in twenty-four to thirty-six hours, and continues for days. Yeast may grow well in the serum of blood, and the products of intestinal digestion are favourable to its growth. Mineral salts (alkali phosphates) are necessary ingredients for the nutrition of yeast-cells (Pasteur). Iron salts in large proportion are injurious. Potassium phosphate is very favourable; sodium phosphate ineffectual; magnesium salts favourable. According to Mr. Salamon (Cantor Lectures, *Society of Arts Journal*, Oct. 1888), phosphorus, sulphur, potassium, together with either calcium or magnesium, have been shown to be essentials; other mineral ingredients, such as chloride of sodium (salt) may be, and probably are, of vast importance in controlling the production of the proper type of yeast-food. If now we turn to the consideration of the composition of the normal wort, we find that all the most favourable conditions are obtained. Carbohydrates are in their most desirable form as maltose and dextrin. Nitrogenous bodies are represented by proteids and amides, and there is abundant though not excessive supply of mineral elements.

The commonest ferment of wine is, according to Pasteur, *saccharomyces ellipsoideus*, which is found on the surface of the grape, and introduced into the fermenting vats. The cells, which have an average diameter of about 10 micro-millimetres (about $\frac{1}{2500}$ in.), grow by budding and division; but if their development is hindered, say by the drying up of the containing liquid, globules or *spores* are given off, and these, when carried to a suitable nidus, reproduce the original form of the fungus. They are capable of resisting dryness, very high temperature, and various conditions for a long time without losing their power of germination.

Yeast of the species commonly used in breweries (*saccharomyces cerevisiae*) is only one among many fungi capable of inciting alcoholic fermentation. A large number of kinds of saccharomyces can ferment maltose, but *S. exiguus* and *S. apiculatus* are unable to do so. The various fungi of the saccharomyces class have special facilities for growth and chemical action in special liquids, and this characteristic may be noticed as applicable to a large class of diseases (zymotic) caused by similar organisms.

The following points deserve attention in connection with the behaviour of disease germs in the human body. A large number of organisms are capable of existing on the nutritive material, such as wort, and the vigorous growth of any particular kind depends on the exact condition, composition, and temperature of the material. Yeast has an incubation period, a period of great activity, and a period of decline, after which it cannot be re-started in the resulting product. It is not incapable of growth in animal fluids, such as the serum of blood, detached from the body. It is highly sensitive to the presence of very minute quantities of mineral matter, and this quality has been noticed with most other fungi and microbes. In certain unfavourable conditions, ferment fungi, instead of budding, give out spores, which are capable of resisting cold, heat, dryness, for a long time.

The microbe connected with the ferment of wine, is found in the winter in the excrement of herbivorous animals and on the dung-heap. Other fungi behave in a similar manner. *Saccharomyces apiculatus*, which is found on gooseberries, etc., is washed off them by the rain, dispersed by the wind, and falls to the ground with the fruit, where it remains buried through the winter as a dormant spore; in the summer it returns to the ripened fruit.

We may fairly regard grape-juice as the blood of a plant, and the ferment as a disease which decomposes its constituents. The spores and cells of this disease are widely dispersed over the soil and in the air, and doubtless develop in enormous numbers on organic matter and vegetable *débris* on the surface of the earth.

Another alcoholic ferment, *mycoderma*, has the peculiarity of growing on the surface of alcoholic liquids exposed to the air, when fermentation is over or nearly over. Its growth is very rapid, a few cells are enough to cover the surface in the course of forty-eight hours. It can, in certain liquids, carry on fermentation independently. This fungus may be compared with the diphtheritic fungus which is apt to attack the throat of children recovering from measles. The discovery of the apparent identity of mycoderma with the microbe of the infantile disease, thrush, is remarkable.

The *carpozyma apiculata* of Engel appears to be the most widely diffused ferment in nature. It is found on all kinds of fruit, and it is generally the first to bud in the must. It is probably very commonly present in the air.

Among other kinds of fungi which are largely distributed over the surface of the earth, the following may be noticed.

Bacterium termo, the microbe of impure water, or water exposed to the air in a room, and associated with putrefaction.

This microbe is certainly common, and, according to Sternberg, invariably appears in decomposing albuminous substances.

Bacillus subtilis, or hay bacillus, flourishes on liquids and on damp, solid, nourishing media. They occur largely in air, soil, dust, etc. They form a white efflorescence on the excrement of herbivorous animals; they flourish on potatoes (artificially) and are aerobic. They may be cultivated on blood-serum. The spores exist in great numbers in ordinary hay. Cohn calculated that the hay bacillus multiplies so rapidly that the whole Atlantic could be filled with them, in two days, if their growth were unopposed.

Aspergillus niger develops within twenty-four hours on damp bread, lemon, etc., but especially well in a prepared mixture. After three days spores cover the surface.

The diseases of plants are caused by two chief series of influences: (1) The injurious action of the external, non-living world, such as unfavourable soil, air, temperature, poisons, etc.; or (2) the attacks of living foes, especially parasitic insects and fungi.[1] Many conditions of the environment are both unfavourable to the plant attacked and favourable to the foe which attacks it, or conversely. If a piece of fruit, bread, jam, or dung, be placed on a dish covered with a bell-jar, and kept damp for a day or two in a fairly warm place, it will soon be covered with a dense crop of silky gray fungus. Fine threads stand off like the pile of velvet, and these fine filaments arise from other still finer ones which branch in all directions on and in the substratum, and which serve to hold the fungi in position. The mucor, or mould, consists of erect, aërial filaments (hyphae), and creeping thinner ones which send down numerous branches into the substratum. The submerged hyphae of the whole network (mycelium) absorb the food substance, the aërial make use of this food when digested for growth and reproduction. After some days the tips of the aërial hyphae undergo a change, each of them swelling up into a ball like an inflated bladder, which is full of protoplasm. Each of these globular swellings is about as large as a small pin-head, and its protoplasmic contents soon become divided up into some dozens of separate masses, the young spores. In a few hours the globular swelling may be compared to a bladder full

[1] *Diseases of Plants.* Marshall Ward.

of shot. The globular spore-case gradually becomes brittle and dry, and breaks, scattering the little spores in all directions. The spores are each about $\frac{1}{3000}$ of an inch in diameter. If a spore be placed in a drop of water it will soon germinate and form a hypha resembling the parent structure. This will die down in a short time, unless a drop of sugar solution, moisture from the jam, or other dead vegetable or animal matter be added. In this case it will grow and thrive, forming a mycelium like the natural growth alluded to above. Thus the favourable soil of these fungi (*saprophytes*) is dead and rotting vegetable and animal matter. And where this soil exists, with a certain amount of moisture, the microbe or its spores will quickly be deposited from the air and develop in immense numbers, soon to scatter forth their seed into the air, to be carried to fresh feeding-ground, many perishing on the passage, but those that survive multiplying by millions in a few days.

There is much resemblance in the nature, development, and mode of spread, of saprophytes and of fungi or microbic diseases of living plants. In some instances the same fungus may subsist alternately or equally well on living and on dead organic matter. It is only recently that the life history of the most formidable fungi, blights, or microbes feeding on living and dead vegetable matter has been laid open to view.

"In no region of science has superstition held sway more tenaciously, perhaps; and even to-day there are not wanting country people who believe that 'blights' and 'mildews' are mysterious visitations. . . ."

The following are among the principal diseases of plants, and may be briefly noticed, as typical of the microbic pests of the vegetable world.

Peronospora Viticola, "*Mildew*." This growth in many respects resembles the "mucor" which has been already noticed as developing on damp organic matter, such as jam and stable manure. It causes great destruction among vineyards. The zoospores, little actively-moving microbes, about $\frac{1}{2500}$ inch in length, if put in a drop of water on a vine-leaf, bore by tubes which they put out into the vine-leaf; each germ-tube grows up eventually into a mycelium between the living cells of the leaf, feeding on their contents and killing them. The hyphae of the mycelium pierce the cells and absorb food. The conidia of the aërial hyphae sown in a drop of water germinate, and the particles of protoplasm thrown out move about and at last escape actively into the water. These again (zoospores) when sown on another damp leaf reproduce the mycelium as before. The spread of this disease is favoured by damp weather, and it is probable that the conidia are conveyed from plant to plant through the air. Both peronospora and oidium, another very destructive vine disease, were brought to Europe from America. The spores of oidium escape into the air as fine dust, and spread with extreme facility. When a spore lodges on a leaf, it germinates with moisture and warmth, pierces the epidermis, and grows.

The *pythium* or *damping off* of seedlings, mustard and cress, etc., especially where these are too thick together and subject to damp, is a disease which grows by the hyphae secreting at the blunt tip a ferment which dissolves the cell-walls of the seedling, wherever it comes in contact with it. Thus it passes from cell to cell, feeding upon them. The spores germinate on the damp soil, so that the first places attacked are the lower parts of the stems. Sometimes this process may be varied, and tubes are put forth which produce zoospores. These after a short time of active movement come to rest, put out delicate hypha-like processes, which bore their way into the cells, and mycelium is rapidly developed. Moreover the pythium has the very remarkable power of going through various transformations by which it forms an oospore, protected by a thick and tough coat, enabling it to endure the winter and to remain a long time without germination. In the spring the film bursts, and a hypha is put forth which develops spores, zoospores, etc. as before. It can for some time live as a saprophyte, as well as in the parasitic state, so that it is difficult to remove from the seed-bed where it has been abundant.

Potato-disease spreads by the hypha developed from a zoospore dissolving its way into and through the cell-wall of an epidermis cell of leaf, finds its way into the living substance, starts a new mycelium, the branches of which spread with enormous rapidity. The zoospores can also penetrate the skin of young potato-tubers if these are lying on the surface of the soil. Millions of zoospores may be developed in a few hours in moist warm weather. Leaf flaps upon leaf over the whole area; quite apart from wind-blown conidia, the zoospores can spread from any centre. The sudden and widespread blight which makes the farmer think that many of the plants are suddenly attacked together owing to some general influence, is really due to the simultaneous development of millions of zoospores, which have been distributed over the field during the preceding days or weeks. The obvious connection between the pestilence and the weather is that the latter favours the rapid development of the fungus. Measures of prevention:

(1) Take all precautions that tend to prevent the fungus from establishing itself in the potato fields; (2) select varieties offering most obstacles to the fungus; (3) gather haulms into heaps of fermenting manure, or burn if possible. Cover tubers with soil where the disease appears. Spores are blown by the wind, flapped from leaf to leaf, carried on clothes, fur of animals, feathers of birds, and insects.

The *Smut* of Corn, a fungus, enters the seedling when it is still very young, and then grows up with the growing plant, and does not show itself till the fruit begins to ripen. The sooty grains are spores which will germinate in water; about $\frac{1}{5000}$ inch. "Their extreme lightness when dry enables them to float in the air; countless millions may be formed on a small patch of corn-plants. These spores may be retained dry for many years and still preserve their power of germination and infection. In a drop of water they germinate in from twelve to forty-eight hours. On germination the outer covering bursts, a protoplasmic tube emerges, and this grows in length, divided into about three partitions. In a few hours, each segment has given rise to an extremely minute process, which separates off as an independent organ. These sporidia, usually in pairs, infect the young corn-plants.

The sporidium, in contact with the moist tissues of the very young corn-plant, when the little root is emerging from the seed and entering the soil, creates an extremely delicate germinal tube, which bores into the young cells. All danger is past when the cell-walls are older and thicker. The germinal tube bores its way from cell to cell, and reaches the growing apex in the bud of the shoot. Here it permeates the plant, and all this is not seen. But when the plant is engaged in swelling out the grain with starch, etc., the parasite revels in these stores, forming a dense network of hyphae in the grain. Now, as it was plain by these discoveries that the life of the smut coincided with the development of the grain, and that it was situated on it, modes of dressing grain came into use by which the disease has almost been got rid of from our cornfields. The seed-corn is soaked in a weak solution of sulphate of copper, then rapidly removed and dried for sowing. Rapid singeing has been tried, but the spores when dry will stand a very high temperature for a short time. Freezing has no effect. Still, despite these measures, the "bunt" or "smut" continued to appear in places, even with the best dressings. It was then shown that invasion took place from spores which existed on wild and cultivated grasses. Moreover, Brefeld found that in watery extracts of manure or vegetable substances the sporidia sprout on their own account, and give rise to many others, as long as food holds out. The products in twenty-four hours amount to many millions. But the hyphae must be ready to attack the tender seedling *at the right moment* in order to infect it.

The *exoascus* of plums, etc. attacks fruit, and the spores sprout like yeast-cells. Moreover, the mycelium remains attached to the branches, and may endure the winter, and be ready to renew the invasion of the fruit when it appears.

The *lily disease* is produced by a mycelium fungus. The conidia are transferred by wind, insects, etc., and favoured by damp. The hypha bores its way by aid of a soluble substance. Sclerotia containing masses of mycelium survive hard weather and exposure, having a tough outer surface. A peziza, a very complex structure, springs from the sclerotium. The peziza fires off ascospores, which are carried by the wind or otherwise to rich soil near plants. Here they germinate, and their hyphae feed on the organic matter extracted by rain, etc. In a short time the mycelium produced may creep along the soil, and the tips of hyphae bore into the tissues, or the mycelium may produce the botrytis or polyactis form, the conidia of which directly affect the plant. Then the fungus, from inside the plant, sends forth hundreds of thousands of conidia-bearing hyphae, and sheds millions of spores on the plants around. Some conidia are scented and attract insects, and so gain access to flowers. In dry summers the lilies show only a few spots; but in dull, cold, damp seasons the tissues remain for a long time in a soft "susceptible" condition, and the flower-buds may be all destroyed.

The *trametes radiciperda* spreads in the wood of the roots of pines, firs, and other conifers, and takes its nourishment from the wood-substance, etc.[1] The spores germinate in the moisture around the roots, and put forth filaments which enter between the bark-scales; thus the mycelium establishes itself between the cortex and the wood. The spores may be carried from place to place by mice and other burrowing animals. The mycelium can spread to another root of another tree, if this comes in contact with one already infected. The filaments of this fungus pierce the walls of the cells of timber by means of a secretion, a soluble ferment, which they exude.

The *agaricus melleus*, a toad-stool parasite producing

[1] *Timber, and some of its Diseases.* Marshall Ward.

fatal disease in trees, extends beneath the soil by rhizomorphs reaching several feet in length; on reaching the root of another tree, the tips of the rhizomorph penetrate the living cortex, and spread into the vessels, tracheides, etc. of the wood.

Trees are subject to a number of diseases through *wound parasites,* which attack at the surfaces of wounds, cut branches, torn bark, frost cracks, etc., and spread thence to the sound timber. Squirrels, rats, cattle, etc., nibble or rub off bark; snow and dew (rime) break branches; insects bore into stems; wind, hail, etc., injure young parts of trees, and thus the fungi gain access. "Many a fine oak and beech perishes before its time, or the timber becomes diseased, because the spores of one of these fungi alight on the torn or cut surface of a pruned or broken branch."

Several diseases of trees and plants are found to have a double life, part of which is spent on one kind of plant and part on another. Thus a very disastrous disease of pine trees, the *Peridermium pini*, has been shown to be a form of a disease which is very common in groundsel, the *Coleosporium senecionis*. Spores from the former sown on the leaf of groundsel give rise to hyphae which enter the stomata of the groundsel, and there develop the well-known fungus which spreads in the leaf-passages of this plant. It is important in nurseries of young trees to keep the ground clean from groundsel, since they harbour the coleosporium under the best conditions for infection.

Similarly, the aecidium on the barberry is a phase in the life-history of the fungus which causes wheat-rust.

The process by which plant-diseases are able to infect through wounds is usually somewhat as follows :—The wood exposed to the air decays, apparently partly through chemical action produced by damp, by oxygen, and by gases, etc. contained in rain, and partly through the action of mould-fungi and bacteria which obtain a lodgment on the altered surface. The decomposed organic matter becomes a suitable soil for the development of fungi which are not parasitic on living parts, and spores from these are very abundant. The hyphae follow up the poisonous action of the juices of moulds, etc., which have converted the outer parts of the wood into a mixture of acid substances resembling the humus of black leaf-mould. In addition to such decay as this, it is found that if the spores of true wound-parasites alight on the damp surface of the cut or broken branch, their mycelium can extend into the still healthy and living tissues, and then, whether the wound closes over quickly or slowly, the tree is doomed.

Mildew of Hop-plants. The mildew of hops appears to attack plants of all degrees of healthiness. De Bary found that the potato-blight attacked healthy and unhealthy plants equally, and that wherever the spores rest, and moisture is present, the disease will be generated.[1] The same, *mutatis mutandis*, was found by Marshall Ward to hold with regard to the coffee-mildew. Hop-mildew, like so many other plant diseases, is a mycelium, producing spores.

The hop-mildew is borne by the wind, and the innumerable spores easily infect neighbouring hop-gardens. Large hedge-rows and woods are some pro-

[1] *Journal of the Bath and West of England Society*, 1883–4: "Mould and Mildew on Hop-plants," by C. Whitehead.

tection against spread from field to field. Spores of mildew are conveyed in "sets," and in this way a whole plantation may be infected. Sets from gardens where mildew has never occurred do not, as a rule, become affected, unless exposed to infection. Hop-planters have unconsciously harboured the mildew by allowing bines to lie about on and near the hop-grounds, and by putting them into yards for manure, with which the spores are conveyed back again to them. Growing hops upon wire is some security against infective spores, which are often retained in the poles. A few spots of mildew may furnish spores sufficient to affect the hop-plants upon hundreds of acres.

Coffee-mildew. According to Mr. M. Ward, something like 150,000 spores of this mildew were on one "disease-spot" on a leaf of the coffee-plant, and on one pair of leaves there were 127 such spots. A strip of glass, smeared with glycerine and placed at some distance off, was found to have caught 117 spores at the end of twelve hours. All means should be at once taken, when these mildews first appear, to stop their further spread.

Pebrine, the silk-worm disease. Pasteur discovered and followed out with admirable skill and completeness the various modes in which this disease is propagated. The worms inoculate each other with the microbe by the infliction of wounds with their claws. He washed the claws and found corpuscles in the water. One "corpusculous repast" is sufficient to infect the worms; they look healthy, the microscope will not reveal the existence of the corpuscles, the cocoons leave nothing to be desired. But the germs multiply in the cocoons and in the moths, and the eggs of these moths are poisoned so that the worms from them are smitten hopelessly with the disease. It seems that the microbes ingested are often not large enough to be detected by the microscope until they have grown in the chrysalis or moth. Infection spreads by the association of sick and healthy worms. By separating the worms, and securing healthy stock, that is, moths and eggs quite free from pebrine, Pasteur was able to restore to a great extent the lost silk industry of France, though continually opposed by inveterate prejudice. "Since the commencement of these researches," he says, "I have been constantly exposed to the most obstinate and unjust contradictions, but I have made it a duty to leave no trace of these conflicts in this book."

The germs of pebrine when thoroughly dried lose their virulence or die, hence the dust or *débris* of one year may be innocuous in the following season.

The flacherie and the muscardine, two other diseases of silkworms, were found to be due to parasitic growths, and the remedy, as with pebrine, consists in the careful separation of the sick from the healthy, the removal and destruction of all infected stock and materials, and cleanliness. The microbes of flacherie flourish on mulberry-leaves, and consequently the silkworms are infected with this disease through their food. The organisms may be swallowed by a healthy silkworm, and will not develop nor be distinguishable by the microscope in the intestinal canal, or in the leaf undergoing digestion; but in the intestinal canal of worms with impaired digestion the organisms are found as in the mulberry-leaf. These microbes, which provoke fermentation in the mulberry-leaf, retain their vitality for years, and are not killed by drying. The spores lie latent on the leaves till dew or rain, and a favourable temperature, awaken their activity. Pasteur obtained so accurate a knowledge of pebrine and of flacherie that he could produce either at will, on a given day, and regulate the intensity of the disease. The remedy for flacherie was found in improved hygienic conditions, strengthening the digestion of the silkworms, and in destroying any with the signs of disease. Flacherie is an interesting malady, especially in this respect, that it shows the transmissibility of a disease from a living vegetable substance to a living animal. In the human subject, pellagra, a dreadful disease common among the peasantry of Northern Italy, seems to be caused by the use as food of diseased or mouldy maize, but the effects of the disease may be caused rather by the poison secreted by the microbe than by its life within the body.

Sheep-rot or fluke. The adult fluke in the liver of the sheep produces enormous numbers of eggs, which are distributed with the droppings of the sheep.[1] If these eggs have moisture and a suitable degree of warmth, they continue to live, and in each is formed an embryo. The embryo leaves the eggs and swims in search of the particular snail (a snail so small as to have escaped general observation), *Linnaeus truncnlatus*, within which its future life and growth take place. The embryo bores into the snail, and then grows into the form which is called a spore-cyst. The spore-cyst gives rise to the second generation. This generation is known as *Redia.* The rediae in turn produce the third generation, which has the form of a tadpole, and is called *Cercaria.* The cercariae quit the snail, and enclose themselves in

[1] *Journal of the Royal Agricultural Society,* vol. xix. p. 296. Professor Thomas.

envelopes or cysts, which are attached to the grass. When the grass is eaten by the sheep or other suitable hosts, the young liver-fluke comes out of the cyst and takes up its abode in the liver of the host, and the fatal circle is thus completed. A sheep does not take the infection directly from another sheep, nor a snail directly from another snail. When the snail is absent, there is no liver-rot. In Australia, however, the fluke exists both in sheep and in human beings. *L. trunculatus* is said not to exist there, but eleven other kinds of *Linnaeus* are recorded.

Drainage is usually very efficacious against fluke, and care should be taken against the eggs from diseased sheep being washed into ditches, ponds, or streams. A brook may easily carry the eggs down to land at a lower level. Eggs may be brought in manure, or adhering to the feet of men, horses, or dogs; rabbits and hares largely distribute the parasite.[1] Rabbits are often greatly affected by fluke, and in one case a sudden outbreak of the disease in an isolated flock was shown to have been introduced by rabbits from a neighbouring wood. Sandy soil is unfavourable to fluke, but heavy clay is favourable, for the eggs are washed along its surface into holes, ditches, marshy places, furrows, etc., where water stands, and the eggs will hatch. Salt-marshes are free from fluke, for the salt destroys the embryos, spore-cysts, etc., and also the snail. Dressings of salt or lime should be given to land on which fluke occurs, and the best months for this operation are June and July, when the embryos are hatched. All eggs of liver-fluke should be rigorously

[1] *Journal of the Bath and West of England Society*, 1883-4, by Josiah Goodwin. See also *Nature*, for October 9, 1882, Professor Leuckhardt.

destroyed; manure of rotten sheep or other rotten animal must not be put on wet ground. Rabbits and hares must not be allowed to introduce the eggs. Heavy and wet ground should be thoroughly drained. Precautions should be taken with regard to the access of sheep to wet ditches, pools, etc., and search should be made for snails in these localities.

The liability of sheep to rot seems to be partially due to the fact that they graze more closely than other animals, and that the cercariae attach themselves to the grass close to the ground.

Water-cress should be steeped in salt and water before being eaten, so as to guard against adhering cysts which sometimes infect human beings.

Speaking generally, we may conclude that damp or rather wet ground and wet places, and the presence of certain snails, are required for the prevalence of this disease in animals and men.

Rouget, a form of swine-fever, is due to a bacillus found in the spleen and lymphatic glands of swine which die of the disease. Pasteur and Thuillier made the interesting discovery that "rouget" injected into a rabbit kills it in a few days; that by further passage from rabbit to rabbit the intensity of the disease increases, but that as the strength for the rabbit increases, it diminishes for the pig, so much so, that after a number of passages through rabbits, it becomes a vaccine for swine, exempting from the fatal form of the malady. This discovery has an important bearing on the conversion of vaccines and the different behaviour of specific microbes in human diseases and in animals.

Milk-sickness, a disease fatal to animals and to man in the United States, is due apparently to a microzyme occurring in marshy and unimproved ground.[1]

Pleuro-pneumonia of the Ox. This highly infectious disease has been largely reduced in several countries by legislation compelling notification, isolation, slaughter, and disinfection. In the Netherlands, for instance, in 1876, the slaughter of the whole herd where the disease occurred, was made compulsory by royal decree, and this regulation was followed by a reduction of cases from 1723 in 1876, to 951 in 1877, 698 in 1878, 157 in 1879, and 48 in 1880. It was discovered in the Spoeling district, by post-mortem examination of all cattle slaughtered in the district, that the lungs of cattle often showed the existence of pleuro-pneumonia of which there had been no signs during life. Professor Brown states that pleuro-pneumonia is frequently spread by cattle said to have recovered from an attack, but retaining for a considerable period the power to infect healthy animals with which they have come in contact. Moreover, "it is a fact which is perfectly well known to veterinary pathologists, that a certain proportion of cattle in a herd in which pleuro-pneumonia appears will have the disease in a latent form; in these cases the health of the diseased animals is, so far as can be judged from external appearances, unimpaired, and these apparently healthy animals may be moved in any direction, carrying with them the power to disseminate disease, without exciting the least suspicion that they are the authors of the mischief." (Compare the conveyance of diphtheria by persons apparently unaffected.) "There is no doubt that many outbreaks of pleuro-pneumonia, which have been looked upon as inexplicable, have arisen from the introduction

[1] *Bacteria.* Magnin and Sternberg.

of animals suffering from this variety of the disease, which is far more common than is generally suspected." The means of prevention of pleuro-pneumonia are very clear. Careful regulation of importation of stock, isolation for a period, at least three months, of imported animals as to which there is any suspicion, and registration of the owner, locality, and movements of imported animals; immediate isolation of any herd in which the disease appears, and slaughter of the herd; rigorous disinfection or destruction of sheds where cattle with pleuro-pneumonia have been housed; disinfection of all articles which have been exposed to emanations from the diseased animals; regulation of movements of cattle in affected districts; regulation of removal or use of hay, straw, litter, or other thing commonly used for food of animals or about animals, which has been in the same field, cowshed, or other premises with cattle affected with pleuro-pneumonia; prevention of use of pasture for a period after affected cattle have fed upon it; isolation of cattle which have been at all associated with cattle which were affected.

It is very necessary for successful war against this highly infectious, persistent, and fatal malady, that all regulations should be carried out with promptitude in the most scientific manner and by the Central rather than the Local Authority. The recent change in England by which the prevention of the disease is undertaken by the Central Board of Agriculture, is likely to lead to a great reduction of the pest.

Anthrax—Splenic Fever. The bacillus anthracis is the cause of anthrax or splenic fever, *maladie de sang* of cattle, *sang de rate* of sheep, *fièvre charbonneuse* of horses, and appears in the rabbit, rat, etc., but not in the dog, cat, birds, and cold-blooded animals. It is the wool-sorters' disease in man.[1]

In 1850, MM. Davaine and Rayer noticed in the blood of animals which had died of splenic fever small transparent rods, and after a series of investigations by Koch, Cohn, and others, the true nature of the anthrax virus was determined. In 1876, Koch succeeded in cultivating the microbes outside the body. They consist of rods and spores of living matter, now known as bacillus anthracis. The spores are by far the most potent for infection, and proceed from the rod-like form in large numbers. Inoculated upon animals, the virus speedily produces fatal results. The bacilli in infected blood, if dried, maintain their infective power for five weeks at the furthest. Spore-charged blood, dried and submitted to various conditions, was found to be fully potent after four years, showing the spores to be by far the most dangerous cause of infection. Countless millions of these spores are developed in the body of every animal which has died of splenic fever, and every spore of these millions is competent to produce the disease. The fatality of anthrax is such that, according to Tyndall, in a single district of Russia, that of Novgorod, between 1867 and 1870, over 56,000 horses, cows, and sheep, and 528 human beings perished of the disease. The contagium enters and develops in the blood. Inoculation of dogs, partridges, and sparrows, failed to produce the disease; mice are highly susceptible. Birds were found by Pasteur to become susceptible when the temperature of their blood was artificially lowered, and guinea-pigs to be protected by raising their temperature after inocu-

[1] *Bacteria.* Magnin and Sternberg.

lation. The spores of anthrax retain their vitality for months in drinking-water and on moist soils.

The spores of the bacillus are so tenacious of life that Pasteur found them living in pits where oxen had been buried ten years before. Earthworms swallowed them, brought them to the surface, and the disease broke out afresh. The bacillus was especially found in the casts of earthworms. A cow was made very ill, and a goat died, from eating clover stolen from a corner of a field where sheep dead of anthrax had been buried. Pasteur found that by keeping infected broth at a temperature of 110° F. he could prevent spores from being developed, and could induce the bacillus to multiply itself by subdivision. He could then attenuate the organism by cultivation and exposure to the atmosphere; this virus inoculated on animals gave protection with slight constitutional disturbance. The spores produced by organisms at any stage of attenuation give rise to a race presenting the same degree of attenuation, so that when once a virus sufficiently attenuated has been obtained, it has only to be allowed to produce spores to secure a vaccine that will keep indefinitely, and is ready for use when required. It may be restored to its original virulence by being passed through guinea-pigs. Since 1881, 170,000 animals have been inoculated for charbon (anthrax) in France, and the mortality reduced in sheep from 10 to 1 per cent. Inoculation is allowed for by the insurance societies.

In the condition of spores anthrax lies hid in wool and hair, and finding its way to the lungs of people handling these, it causes the terrible malady known as Wool-sorters' disease. When accidentally inoculated on man it causes malignant pustule.

Chauveau found that the strange resistance of Algerian sheep to anthrax can be overcome by inoculation with large doses.

The extirpation of anthrax would appear to be best contrived by measures of isolation and disinfection, by destruction by fire or other means of the remains of animals dead of anthrax, by care as to pasturage where affected animals have fed or bodies been buried, by general cleanliness and ventilation, and, where necessary, protection by inoculation with attenuated cultures. Inoculation at present has certain drawbacks; some animals die of the attenuated culture disease, which is too strong for them, and others are not sufficiently protected by it and subsequently die of anthrax; but the majority of any inoculated herd appears to be protected by it.

Symptomatic Anthrax, a different disease, is always fatal to the animals attacked.[1] The bacillus grows chiefly in the tissues. A small intravenous injection of the microbic virus produces immunity, as shown by experiments conducted by the French Government A large injection produces fatal symptomatic anthrax.

Cattle Plague (typhus of horned cattle—steppe-murrain) is with reason ascribed to a microbe, but this has not apparently been identified. The disease arises in Central Asia, where every condition of health is disregarded, and where many other diseases, both human and animal, are cultivated. Early in this century cattle plague was brought into Austria and Prussia by steppe cattle being driven to Dantzig in consequence of the war.[2] M. de Berg has observed that "cattle plague is often propagated most rapidly in the country

[1] *Bacteria.* Magnin and Sternberg.

[2] Fleming's *Animal Plagues.*

which is best supplied with veterinary aid. The reason is simple. The surgeon often enters an infected cowhouse without being at all aware of it. The contagious malady has not yet displayed its usual and fatal symptoms. He attends to the case before him, and then to the animals suffering from some of the numerous diseases to which cattle are subject; and so, unaware of the mischief, he carries with him the contagion, and spreads it far and wide. He carries the poison on everything he has about him, and especially in the woollen clothes that he wears." The infected animal is capable of communicating the disease before it is recognized. A cowhouse remains infected though twenty fumigations are applied. There was a stable at St. Laurent de Chemaisset, which after innumerable fumigations, whitewashing walls, scraping of beams, mangers, and racks, renewal of pavement, scouring of vessels, was yet a source of infection. It may be necessary to pull down buildings.

Some light is thrown on the origin of certain animal plagues by the fatal cattle and sheep disease (*cachexia aquosa*) which appeared every year on the subsidence of the Nile, and was extraordinarily fatal in 1829. It keeps pace with the subsidence of the waters, and gradually extends downwards from Upper Egypt. The area of its prevalence is very low and marshy, and the sheep pasture in the midst of the mud. In similar conditions, in Brazil, a violent epidemic followed a long drought, which transformed the Bay of Rio and the low-lying swamps into immense marshes.

Mr. Netten Radcliffe, commenting on the results of the Royal Commission of 1865-6 on the cattle plague, observes that preconceived doctrines of some occult epidemic influence were shown to be groundless: the disease was found to be fully within human control.

Foot and Mouth Disease. Mr. Hayes of Rochdale, in his *Report on Foot and Mouth Disease* in 1841, says[1]:—"I have found in general that the servants or other persons have come in contact with other neighbours' infected stock previous to their own becoming diseased. I am of opinion that it is carried or communicated from one animal to another by contact, either actual, or conveyed by some intervening body in some shape or other, and not by atmospheric influence; for I have known many cows that have been bought during the last eight months from farmers whose stock had not been affected, nor have been so since; yet these cows, after being tied up in stalls where diseased cows had stood before, on the next morning had their feet affected, and on the next day their mouths, and in a day or two afterwards the disease was fully developed. Yet the remainder of the stocks whence these cows came have remained quite free a period of four months. I also know of several farmers who have not allowed any person connected with their cattle to go near the stock of another farmer where they know the stock to be or to have been affected, nor any other person to come among theirs, and certainly all who took such rigid precautions have escaped this pestilence."

"There is no evidence," says Fleming, "to show that any legislative attempt was made to check the progress of the disease; indeed, it does not seem to have struck our legislators that there was any occasion for a sanitary police, and no one appears to have sug-

[1] Fleming's *Animal Plagues.*

gested the necessity for preventing its spread. The introduction, diffusion, and degree of intensity of the malady was doubtless greatly influenced by the trade in foreign cattle."

All this is now happily changed. Vigorous measures are taken to prevent the spread of this plague by the Central Authority. Cautions are circulated (Feb. 20, 1892) containing the instructions that "foot and mouth disease is propagated with the greatest ease by persons, animals, or substances which have been in contact with the infective matter, as well as by contact with diseased animals," and that "no one should be permitted to come in contact with cases of the disease excepting those persons who are provided with a proper dress which can be easily disinfected." It is noted that infection is carried also by the hands and by the boots.

Fowl Cholera. This destructive disease has been studied by Pasteur and others. Duclaux mentions that if a fowl be inoculated with a few drops from a culture of fowl cholera, it sickens and dies; but if the liquid has been filtered through plaster or porous china (thus removing the microbes) the bird only falls into a passing sleep, from which it recovers in a few hours. Pasteur has used attenuated culture as a protective virus.

Cattle Diseases. The proper and thorough disinfection of cattle-trucks, yards, sheds, etc., is very important, but is not common at present. M. Rédard, medical inspector of railways in France, communicated to the Academy of Medicine the results of his experiments on disinfection.[1] He stated that epizootics had greatly increased since the existence of railways. Animals were frequently ill when sent. Disinfection

[1] *Sanitary Record*, Sept. 15, 1885.

of trucks is inefficient. Animals were inoculated with the "disinfected" virus of septicaemia, charbon, glanders, fowl cholera. All those inoculated with fowl cholera died, one in ten of those inoculated with charbon, nine out of ten of those inoculated with septicaemia. Virus disinfected with steam at 100° C. was fatal, but steam at 110° was found to be an efficient disinfectant. Bacillus subtilis, one of the most refractory, was killed at this temperature. Neither steam at 100° nor chemical disinfectants were found efficient.

Infection and Inoculation—Diseases of Animals. The vaccine of cow-pox diluted to 1 in 50 makes inoculations uncertain; the "claveau" of sheep diluted to 1 in 100 gives as many pustules as pricks or injections; diluted to 1 in 500, 13 out of 21 injections take; diluted to 1 in 10,000, 1 in 20 is effective.[1] That is to say the claveau is thirty times richer in virulent particles than cow-pox. Now a subject of "claveau" or "clavelée" furnishes a hundred times as much virulent matter as a subject of cow-pox, therefore the former gives out three thousand times as many virulent corpuscles as the latter. Moreover, in the sheep disease the nasal mucus, etc., is often charged with contagious matter; in cow-pox only the matter of the pustules. In cattle plague the humours of the eye, saliva, urine, etc., can convey contagion. The virus from the lungs of a sheep in some cases of the claveau might alone inoculate or infect half the sheep of France. The bacilli of cow-pox, clavelée, anthrax, and suppuration are found effective by insufflation.

[1] *Les Virus.* By M. Arloing, Principal of the Veterinary College of Lyons.

CHOLERA.

CHOLERA is a very fatal disease endemic in the delta of the Ganges, and frequently prevalent in various other parts of India, but varying much from year to year. It was not known in Europe till the beginning of the nineteenth century. It has three times passed from India to Russia and Europe overland. Once it was brought by Mecca pilgrims to Egypt, thence to Marseilles, and thence by a woman to Paris, in 1865.[1] In 1884, Alexandria, Naples, Marseilles, Toulon, Nantes, Paris, and Spain were attacked. In August 1885 it reappeared at Toulon. The epidemics of 1865, 1873, and 1884 came to France *viâ* the Mediterranean Sea. The essentially epidemic and contagious progress of this disease clearly indicates the presence of a microbe, of which the chosen seat is the intestines, whence it passes into the fæces, and constitutes the contagious element in places attacked. This microbe is provisionally believed to be the comma bacillus discovered by Koch, and Nicati and Rietsch were successful at Marseilles in producing cholera in animals by a choleraic injection; the intestines of these animals were then found to contain numbers of comma bacilli much more vigorous than those of the injection.[2] Acids

[1] Trouessart, *Microbes, Ferments, and Moulds.*

[2] These experiments appear to have been confirmed by Watson Cheyne.

are adverse to the development of this microbe. It is by the human body and its clothing, or by the water which carries away human fæces, or has served for the washing of foul linen, that the infecting microbes are carried. The air need not be taken into account, except in close proximity to cases. According to Duclaux, the sun and air soon attenuate and destroy the microbes, but their virulence may long remain unimpaired in packages of clothing, bales of merchandise, and the close, moist hold of a vessel.

The Cholera Commission of 1866 found that India is the permanent home of cholera; that cholera is propagated by man, with a swiftness proportioned to the rapidity of his movements; that no fact has been brought forward to show that it is spread by the atmosphere alone, but that water and certain other articles of consumption may serve as vehicles for the poison, and that the movements of pilgrims are the most powerful of all causes tending to its propagation and development.[1] Owing to sanitary measures, outbreaks at fairs and festivals are less frequent there than in former periods. By sanitary measures a mass of 3,000,000 people assembled at Hurdwan were kept free from cholera until after the bathing. When it broke out, it was carried in all directions, 300 to 700 miles.

The following conclusions, among others, were adopted by the International Sanitary Conference held at Vienna in July 1874:

Asiatic cholera is spontaneously developed in India, and has been introduced thence into other countries. It is not endemic except in India. It is transmissible by man when he comes from a place where the germ of the

[1] Pritchard's *Administration of India*, p. 284.

disease already exists. It can be transmitted by personal effects coming from an infected place, especially such as have been used by cholera patients, and certain facts show that the disease can be carried to a distance by these effects if shut up so as to prevent free contact with the air. Cholera can be propagated by drinks, particularly by water. It is possibly transmitted by merchandise under certain conditions. No fact is yet known which proves that cholera can be transmitted to a distance by the air alone, whatever its condition. Moreover, it is a law, without exception, that an epidemic of cholera is not propagated from one place to another in a shorter time than it would take a man to travel the intervening distance. The surrounding air is the chief vehicle of the generative agent of cholera, but the transmission of the malady by the atmosphere, in the immense majority of instances, is restricted to the close vicinity of the focus of emission. In free air the cause of cholera rapidly loses its morbific activity, but in certain conditions of confinement this activity may be preserved during an undetermined time. The period of incubation of cholera does not exceed a few days. The Conference recognizes the great value of hygienic measures, such as ventilation, thorough cleansing, etc., combined with the use of substances regarded as disinfectants. Ships coming from suspected or infected ports should be rigorously inspected. If any case of cholera, or of a suspicious character, have occurred, the ship, the passengers, and all personal effects should be rigorously disinfected, all patients on board to be removed immediately to an isolated hospital.

Where quarantine prevails, arrivals from infected ports should be kept in quarantine for periods of one to ten days, during which thorough disinfection should be carried out. Special precautions may be adopted in the case of emigrant ships, and in other cases of peculiar gravity.

At the Brussels Conference, in 1875, on the Prevention of Cholera, the following were among the resolutions adopted[1]—IV. The cholerigenic miasma is spontaneously developed in certain conditions in India, notably in the delta of the Ganges and the flat lands which surround Madras and Bombay. Hence it has migrated to Europe, Africa, and America. However, limited epidemics have occurred in Europe, and it is a question whether these explosions are due to the spontaneous production of the cholerigenic miasma on European soil, or if they must be attributed to the slow development of miasma left by the preceding Asiatic epidemic. The last is the most generally adopted opinion, but it is none the less true that the Indian cholera can acclimatize itself on European soil. V. Cholera is contagious. 2. It can be dissolved in water and diffused in air. 4. It is not very lasting, and appears to be easily destroyed, especially when the air is strongly ozonized. However, in certain confined conditions, sheltered from the air, it may last a long time. 6. Persons exposed to the miasma may acquire after some time a kind of acclimatization which protects them. VI. Contagion in the ejections. The sources of contagion are the ejecta, the corpse, linen, clothes, ships, rooms, carriages, latrines, contaminated water, the air at a short distance only, animals and merchandise. VII. The miasma penetrates by the pulmonary and digestive passages. The duration of incubation is generally very short. VIII. The first indication is to

[1] *Sanitary Record,* Nov. 13, 1875.

destroy the original *foci* of the disease in India and in Europe by sanitary works. Isolation and disinfection are highly important.

The above conclusions, only in fuller detail, were arrived at with almost perfect unanimity by the Conference, and agreed with those of the Vienna Conference of 1874.

An International Committee of experts at the Sanitary Conference held in Rome in June 1885, consisting of Dr. Sternberg, Dr. Koch, Dr. Provost, Dr. Thorne, Dr. Eck, Dr. Semmola, and Dr. Hoffmann, recommended as a means of disinfection against cholera, with especial reference to vessels and their reception and treatment at ports of arrival, the following[1]—

1. Steam at 100° C. (212° F.). 2. Carbolic acid and chloride of lime. 3. Aëration.

Carbolic acid and chloride of lime to be used in aqueous solutions. Weak solutions: carbolic acid, 2 per cent.; chloride of lime, 1 per cent. Strong solutions: carbolic acid, 5 per cent.; chloride of lime, 4 per cent.

I. For the disinfection of the person weak solutions should be employed.

II. For clothing, bedding, etc., (*a*) destruction; (*b*) steam passed through the articles for one hour (presumably at least as high as 212° F.); (*c*) boiling for thirty minutes; (*d*) immersion for twenty-four hours in one of the weak solutions; (*e*) aëration for three or four weeks, but only in case the other means recommended are inapplicable. Articles of leather, such as trunks, boots, etc., should be either destroyed or washed several times with one of the weak disinfecting solutions.

III. Vomited matter and the dejections of the sick

[1] *Sanitary Record*, Aug. 15, 1885.

should be mixed with one of the strong disinfecting solutions, in quantity equal to the amount of material to be disinfected. Linen, clothing, etc., which cannot be immediately steamed as described, should be at once plunged into one of the strong disinfecting solutions and left for four hours.

IV. The dead should be enveloped in a sheet saturated with one of the strong disinfecting solutions, without previous washing, and at once placed in a coffin.

V. Steam under pressure is the only reliable disinfectant of rags.

VI. When cholera occurs on a vessel at sea, the place in the vessel where the case occurs should be disinfected. The bilge-water should be pumped out and replaced by sea-water at least twice at each disinfection of the vessel. The closets should be well watered with one of the strong solutions at least twice a day.

VII. If the drinking-water is open to suspicion, it should be boiled before it is used, and the boiling should be repeated, if it is not used within twenty-four hours. All suspected food should be destroyed.

VIII. Hospitals should be disinfected by washing the floors and walls with one of the weak solutions, by a subsequent free ventilation and cleansing, and finally by re-painting. The wards to be disinfected should as far as possible be isolated from those in use. Latrines to be disinfected at least twice a day with the strong solutions, in quantity at least equal to the amount of dejecta received since the last disinfection.

IX. The clothing worn by physicians and attendants should remain in the hospital, and should be regularly disinfected. Physicians and attendants should use the weak solution for washing their hands, etc.

The Local Government Board issued on the 18th July, 1883, a Circular to the local sanitary authorities inclosing copies of a memorandum prepared by the Board's medical officer on the precautions to be adopted in view of the approach of cholera, which was then rife in several parts of Egypt, in frequent communication with this country. The following points, among others, were brought to public notice. The sanitary authorities of the sea-coast were armed with special powers, to enable them to deal with any cases of cholera, and to prevent the spread of the disease. The following considerations, according to the Circular, were to be borne in mind—"Any choleraic discharge, cast without previous thorough disinfection into any cesspool or drain, or other depository or conduit of filth, infects the excremental matters with which it there mingles, and, probably, more or less, the effluvia which those matters evolve; secondly, that the infective power of choleraic discharges attaches to whatever bedding, clothing, towels, and like things have been imbued with them, and renders those things, if not thoroughly disinfected,[1] as capable of spreading the disease in places to which they are sent, as, in like circumstances, the patient himself would be; thirdly, that if by leakage or soakage from cesspools or drains, or through reckless casting out of slops and wash-water, any taint, however small, of the infective material gets access to wells or other sources of drinking-water, it imparts to enormous volumes of water the power of propagating the disease.

[1] Thorough disinfection means much more than mere mixing with antiseptics. Probably fire or prolonged boiling would be safest.

When due regard is had to these possibilities of indirect infection, there will be no difficulty in understanding that even a single case of cholera, perhaps of the slightest degree, and perhaps quite unsuspected in the neighbourhood, may, if local circumstances co-operate, exert a terribly infective power on considerable masses of the population.

"The dangers which have to be guarded against as favouring the spread of cholera infection are particularly two. First, and above all, there is the danger of *water-supplies* which are in any (even the slightest) degree tainted by house-refuse or other like kinds of filth; as where there is outflow, leakage, or filtration from sewers, house-drains, privies, cesspools, foul ditches, or the like, into springs, streams, wells, or reservoirs, from which the supply of water is drawn, or into the soil in which the wells are situate; a danger which may exist on a small scale (but perhaps often repeated in the same district) at the pump or dip-well of a private house, or, on a large and even a vast scale, in the source of public waterworks. And, secondly, there is the danger of breathing air which is foul with effluvia from the same sort of impurity.

"Immediate and searching examination of sources of water-supply should be made in all cases where the source is in any degree open to the suspicion of impurity; and the water both from private and public sources should be examined. Where pollution is discovered, everything practicable should be done to prevent the pollution from continuing, or, if this object cannot be attained, to prevent the water from being drunk. Cisterns should be cleaned, and any connections of waste-pipes with drains should be severed.

"Simultaneously, there should be immediate thorough removal of every sort of house-refuse and other filth which has accumulated in neglected places; future accumulations of the same sort should be prevented; attention should be given to all defects of house-drains through which offensive smells are let into houses; thorough washing and lime-washing of uncleanly premises, especially of such as are densely occupied, should be practised again and again.

"It may fairly be believed that, in considerable parts of the country, conditions favourable to the spread of cholera are now less abundant than at any former time; and in this connection, the gratifying fact deserves to be recorded, that during recent years enteric fever, the disease which in its methods of extension bears the nearest resemblance to cholera, has continuously and notably declined in England. But it is certain that in many places such conditions are present as would, if cholera were introduced, assist in the spread of that disease. It is to be hoped that in all these cases, the local sanitary authorities will *at once* do everything that can be done to put their districts into a wholesome state. Measures of cleanliness taken beforehand are of far more importance for the protection of a district against cholera than removal or disinfection of filth after the disease has actually made its appearance.

"It is important for the public very distinctly to remember that pains taken and costs incurred for the purposes to which this Memorandum refers cannot in any event be regarded as wasted. The local conditions which would enable cholera, if imported, to spread its infection in this country are conditions which day by day, in the absence of cholera, create and spread other diseases; diseases which, as being never absent from the country, are in the long run far more destructive than cholera; and the sanitary improvements which would justify a sense of security against any apprehended importation of cholera would, to their extent, though cholera should never reappear in England, give amply remunerative results in the prevention of those other diseases."

Hirsch says cholera was certainly imported to Germany from Poland by raftsmen in the epidemic of 1873, and recommends the disinfection of rafts. According to Geigel, Denmark was almost free from cholera in 1830, owing to the full vigour of quarantine; then in 1852 quarantine was abolished owing to medical men taking the "miasmatic" view of the disease, and in consequence Copenhagen suffered in 1853 from a great epidemic. In 1857, measures were adopted which prevented the recurrence of cholera, viz. patients were isolated and disinfected, and proper means between complete prohibition of intercourse and uncontrolled freedom were adopted. Ashpits were removed, water-supply attended to, and lazarets established. Every vessel was examined, and where patients were on board, they were taken to an isolated hospital, and the goods and ship were cleaned and disinfected.

Each seaport should have an isolated hospital. If cholera breaks out in a port, stringent supervision should be exercised over lodging-houses, especially over sailors and vagrants. Closets should be disinfected, especially at stations, inns, etc. The first cases in a town should be traced with the greatest care. Doctors should be compelled to report weekly to authorities. Houses in which the first cases occur should be examined, patients removed, and others likely to have contracted the disease should be kept in a proper place for a week. All other occupants of the house should be examined for the same period. Small dark damp sleeping-rooms near closets are the most attacked. Putrefaction alone can promote perfect cholera. Dysentery and cholera spread everywhere by intercourse. The poison never forms autochthonically. A body inoculated with the cholera poison seems incapable of a new reception of it. Compounds of chlorine, of phenol, and of carbolic acid were recommended as disinfectants by the Paris Commission.

The above recommendations and opinions are quoted from Hirsch, Geigel, Schleisner, Giegl, and Ranke.[1] These all declare more or less strongly in favour of the contagionist view of cholera. Pettenkofer, however, makes it depend on soil and spring-water. Taking a broad view of the conditions of outbreaks in various countries, we cannot fail to observe that ordinary intercourse and contact are in general the means of propagation, but the most potent medium, locally, is contaminated soil and water, in which the microbe flourishes and multiplies.

The comma bacillus (supposed to be the cause of cholera) readily multiplies in damp linen, milk, broth, eggs, moistened bread, potatoes, etc. A favourable temperature is from 30° to 40° C. Below 16° it grows very slowly, but a temperature of —10° does not kill it. It is aerobic. It lives twelve hours in distilled water, and a week in ordinary drinking water.[2]

The home of cholera is the Upper Delta of the

[1] *Sanitary Record*, August 21, 1875.
[2] Trouessart, *Int. Scientific Series.*

Ganges, where the land is covered or sodden with water.[1] The Lower Delta is not properly habitable on account of every kind of ordure. The contagium is diffused by pilgrimage, when thousands bathe in a small pool, sweating and exhausted.

With regard to antiseptics, calcium sulphate, carbolic acid, salicyclic acid, and mustard oil are considered useful.

The conditions under which cholera occurs at Shanghai are of peculiar interest.[2] Shanghai stands on an alluvial flat of mid-China, several thousand square miles in extent, at ten miles from the mouth of a branch of the Yang-tse river. The country is cut up in all directions by creeks and artificial water-channels, for transport and irrigation. The ground water-level is rarely so much as ten feet below the surface, and is influenced by the tides much more than by rainfall. The water of the river at Shanghai is fresh. The native walled city contains about 200,000 inhabitants, the foreign settlement about 4000. Cholera appears every summer with regularity. Before the end of July it is rarely met with, by the end of August it is well marked, in September it is at its height, in October not quite so virulent, and after November it disappears till the following summer. The cycle has taken place during twenty years at least. June is damp and hot; July and August dry and hot; September hot, damp, and muggy; October is cool. Tropical heat prevails

[1] Trouessart on *Microbes, Ferments, and Moulds.* Int. Scientific Series.

[2] "Enquiry into the Cause of Asiatic Cholera." By Neil Macleod, M.D., and W. J. Milles, F.R.C.S. See *Public Health*, Feb. 1889.

for about two months before the disease breaks out. The country around Shanghai as regards position, soil, water, etc., is strikingly like that of the deltas of the Ganges and the Nile. In each there is the alluvial deposit, rich in organic matter, and the high ground-water level. The perennial prevalence of cholera in the Ganges delta is probably due to the prevalence of high temperature throughout the year. The occasional presence of cholera in Lower Egypt is probably caused by importation and infection, and less suitability of the soil for the growth of the microbe, or of the water-supply for its spread. Probably the number of other pathogenic organisms in the soil of a long-inhabited valley like that of the Nile is greater than at Shanghai. Late summer and autumn is the period for Egyptian epidemics of much extent, as at Shanghai. The Chinese custom with regard to the disposal of excreta is to collect them, convey them to the country, and apply them to the crops, often mixed with water. In this way probably the soil was originally largely dosed with the microbe, and when temperature has been high, and the ground under a hot sun for several weeks, probably an enormous multiplication takes place, and both ground-water and air become infected. A safeguard against cholera would thus appear to be the cooking or boiling of all food and drink, and the prohibition of any deposit of filth on the surface of the earth near towns and dwellings, and, if possible, some method of reducing the level of the ground-water. Uncooked vegetables in China are apt to retain traces of the diluted excreta with which they have been watered, and cholera cases have occurred through eating lettuce, etc. It is very clear that a high temperature of the ground and water are exceedingly favourable to the development of cholera as of diarrhœa. A freezing temperature is known not to destroy the comma bacillus; it grows scarcely at all at 50°, slowly at 60°, rapidly from 80° to 100° Fahrenheit, in gelatine cultures. On potato slices, at a temperature of from 90° to 100° it forms colonies, but does not grow at all at ordinary room temperatures. Growth ceases in the absence of air in gelatine cultivations. Kept moist, it lives for months in pusc-tubers after growth has ceased; dried for a few hours it dies. The organisms were found, usually in abundance, in forty out of forty-four cases of cholera examined by the authors. The authors have reason to conclude that the comma bacillus is invariably present, and associated with certain changes in the small intestine, in cases of Asiatic cholera; that the organism multiplies in the small intestine of certain animals when injected with due precautions, and that there are associated therewith changes similar to those in men in Asiatic cholera; and that there is therefore strong evidence for regarding the comma bacillus of Koch as the cause of Asiatic cholera.

If, with the foregoing investigators, we take the comma bacillus as the cause of cholera, we may easily get some sort of idea of the number of malignant microbes which may be cast upon soil, water, or air in a single case of cholera. If comparable in size, as they appear to be, with the vibrions observed by Pacini, a single cubic inch might contain, closely packed, no less than 15,625,000 of these organisms. Even if this bacillus be not the cause of cholera, it is almost absolutely certain that the cause is a microbe of still smaller size. The rapid multiplication of cholera patients where once a case is introduced among a population, and where the microbe meets with favouring soil, water, and temperature for further multiplication, thus becomes easily intelligible.

According to Koch[1] the comma bacillus is the only form constantly present in cholera, and is present in greatest numbers in acute and uncomplicated cases. It is present in the parts most affected, is never present in other diseases, nor in healthy persons, nor has it been found outside the body when no cholera was in the neighbourhood. Comma bacilli were found, however, in a tank which supplied with drinking-water the inhabitants of a village where cholera prevailed. The natural history of the disease corresponded with the various characteristics of the organism. The bacilli grow rapidly, soon reach their highest point of development, and then die. They do not form spores.

De Chaumont[2] gives the following instances of the manner in which cholera may be propagated and arrested. A soldier with a small hurt was brought from quarters at the head of a valley, where there was no cholera, to a hospital where cholera cases were occurring. Within twenty-four hours he took cholera. Millbank Prison suffered to a great extent from both enteric fever and cholera as long as the Thames near the prison was the source of supply of drinking-water; in 1854 the supply was changed, and since that time no case of cholera or enteric fever has arisen in the gaol.

De Chaumont considers that the drying and drainage of the soil, careful and rapid removal of excreta to a

[1] For abstract of Koch's conclusions, see *Nature*, for Dec. 4 1884.

[2] *Prevention of Cholera*, by F. de Chaumont, M.D., F.R.S.

distance, and disposal of them so that there is no chance of their coming back to be a nuisance, the exercise of careful supervision of water-supplies, and, where suspected, the boiling of drinking-water before use, the burning of refuse, and improvements in closets, are important measures for the prevention of cholera. When the disease actually breaks out in a town or district, a vast deal may be done by measures of isolation, disinfection, and other sanitary measures. Thus Dr. Budd, at Bristol, organized arrangements by which the rate of deaths per 10,000 in 1866 was only $1\frac{1}{2}$ against 82 per 10,000 in 1848 and 1849. According to Sir Edwin Chadwick, a house-to-house visitation was instituted by direction of the Local Government Board, and so admirably did this plan work, that, if any sudden rise in the death-rate took place in any particular town, the Local Government Board at once knew that their recommendations were not being properly carried out, and took steps to see that they were, with the result that the disease was soon mastered.

The researches of Drs. Macleod and Milles[1] leave little doubt that the comma bacillus of Koch is the real cause of cholera. Its length is 1·5 to 2·5 μ; it is aerobic, motile, and multiplies by fission. Among the very important conclusions of the above-named investigators are the following—Pure cultivations of the comma bacillus introduced into the stomach of the guinea-pig produce a disease which causes changes and characteristics like those of cholera in man, and kills about six out of ten. The contents of the ileum of animals killed produce the same effects on other animals

[1] *Micro-organisms*, by A. B. Griffiths, Ph.D., 1891. See *Proc. Roy. Soc. of Edin.*, vol. xvi. p. 18.

as the pure cultivations of the comma bacillus. This bacillus is invariably present in the small intestine in cases of Asiatic cholera. There is no evidence to show that it is a normal inhabitant of the alimentary canal.

Dr. Cornil has shown that good drinking-water can serve as the vehicle of the bacillus, but does not long maintain it.

The poison, or one of the poisons produced by the microbe of cholera has been found to be an alkaloid, which, combined with hydrochloric acid, produces a fatal attack of poisoning in animals.[1]

Dr. Forster[2] found that salt is destructive to cholera bacilli. Calcium sulphate, carbolic acid, thymol, and oil of mustard are also unfavourable to the development of the microbe.

The powers of prevention exercised by Port Sanitary Authorities are very large and important.[3] Under the Quarantine Act all disease whatsoever on board vessels entering a port, and not arriving coastwise, is to be reported to the Customs, who detain the vessel until she is released by the officer of the Sanitary Authority whom they inform. Under the Public Health Act (1875) the removal to hospital of every patient suffering from infectious disease is compulsory; and, subject to the approval of the Local Government Board, a port sanitary authority may make regulations for the compulsory notification and isolation of infectious disease, and disinfection. The Tyne Port Sanitary Authority has always disinfected articles after the removal of a case. In 1885 and 1886, no less than 351 vessels

[1] Griffiths' *Micro-organisms*, p. 94.
[2] *Ibid.* pp. 211, 320.
[3] *Public Health*, June, 1888.

arrived in the Tyne from cholera-infected ports directly, and 509 indirectly; 298 vessels arrived from suspected ports. A vigilant observation is kept of records of cholera in foreign countries, the earliest possible information is obtained from the Customs of arrivals of infected or suspected vessels, printed information is published in the port on *Cholera and its Prevention,* careful inquiry made into the water-supply of the ships, and cases of ailment on board, especially diarrhœa; and special accommodation is provided for cases of cholera. A list of vessels bound to the Tyne from infected ports is kept by the chief inspector, who enters in it the dates of passing different ports on the voyage, time of expected arrival, etc.

The efficacy of well-observed precautions in preventing the extension of cholera is excellently illustrated by the experience of doctors and nurses in the hospitals of Chili during the outbreak of 1886-87. A number of small hospitals were established in different localities of the town; each of the hospitals contained from fifty to sixty beds, and had a staff of six doctors, six students, and thirty attendants. All wore long aprons, reaching from the chin to the feet, and caps. For washing the hands and face a solution of corrosive sublimate (mercuric chloride) was exclusively used. In the dining-room all dishes before use were strongly heated by the flame of burning alcohol. The bread was sterilized by toasting. It is stated that no one of the staff sickened who adhered rigidly to these precautions. The convalescents before their discharge were bathed in the corrosive sublimate solution (1 per 1000), and their clothing was washed in a similar disinfecting fluid. The floors of the hospitals were made of a kind of pine parquet soaked in tar, and were washed daily with a solution either of copper sulphate or potassic permanganate (1 per 1000). On emptying a ward, it was acted on by sulphurous acid gas for twenty-four hours.

By such homely and simple measures we can hardly doubt that cholera might be almost starved out of existence, if large populations could be brought to submit to them.

The cordon was not found wholly effectual in Chili. In one case a drover succeeded in getting through the chief pass to Villa Maria, and sickened of cholera on December 25th; on December 27th eight persons sickened in the town, and soon twenty to fifty were dying every day.

According to Pritchard,[1] cholera generally breaks out in India in the rainy season, when the air is much cooler than in the previous month, the earth damp, the low ground under water, large tracts of country turned into a swamp, and roads often almost impassable.

The condition of Bombay is described as follows, by the Municipal Commissioner, in 1861—"Go into the native town, and around you you will see on all sides filth immeasurable and indescribable, and at places almost unfathomable; filthy animals, filthy habits, filthy streets, and with filthy courtyards around the dwellings of the poor; foul and loathsome trades, crowded houses, foul markets, foul meat and food, foul wells and tanks and swamps, foul smells at every turn, unventilated drains, and sewers choked, and the garbage of an Oriental city. Men, women, and children, the rich and the poor, living with animals of all kinds and

[1] *Administration in India.*

vermin, seeing all this and inhaling the deadly atmosphere and dying by the thousand."

In April 1868, a writer in the *Friend of India* says of the work of Mr. Craufurd—"In three years, assisted by a good health-officer, he has wrought a marvellous revolution. Except in a few obscure lanes, the city is almost devoid of bad odours. Its area is nearly thrice that of municipal Calcutta, and yet every street and house and every road is daily swept as well as watered, and the dust is carefully removed. The natural effect has been seen, not merely in the comfort of all classes of the inhabitants, but in the fact that cholera, which used to be endemic in the city, as in Calcutta, has not been known for some time."

With regard to India generally, it is noted that famine is invariably followed by epidemic disease, either fever or cholera.

The famine in 1861 was followed by an outbreak of cholera, which spread its devastations with remarkable exactness over the area where the scarcity of food had been prevalent, travelling from Benares to beyond the Indus, and from Rajpootana to the Himalayas in the north-west.

Cholera has appeared among workpeople cutting into an old grave-yard where cholera victims had been buried.

Isolation and removal are found to be the great remedies for cholera.[1]

The comma bacillus, supposed by Koch to be the cause of cholera, has been kept 243 days without losing vitality.[2]

Dr. J. Russell, medical officer of Glasgow, states that

[1] Pritchard's *Administration in India.*

[2] Heron, on Cholera Bacillus. *Sanitary Record,* Dec. 15, 1885.

Dr. Farr estimated that there might be 42,000,000 particles of infection set adrift in a case of cholera.

With regard to the importation of cholera, the rapidity of its spread may be understood, where conditions are favourable, by the known example of a man who caught it at Vienna and reached London before sickening.[1] In old days an outbreak in England from such a transportation would have been attributed to some "atmospheric influence."

In Marey's Report to the Academy of Medicine on the Cholera Epidemic of 1884 in France, it is stated that cholera was recognized to be imported in three-fourths of the cases in various localities, and in the remaining fourth there was strong presumptive evidence that it was also imported.[2] Dirty habits, especially omission to remove excrement, were powerful factors in producing it. Storms carried dejecta into drinking-water, and impure water was especially dangerous. Towns with a good water-supply were less affected than towns without a good supply and small country places. Disinfecting according to rules laid down were of the highest importance in preventing its spread.

"Although the water may be naturally pure and good, as at Cannanmore, there can be no guarantee (owing to the carelessness and filthy habits of the watermen and other natives frequenting the wells) that the supply will reach the consumer in a wholesome condition." [3]

[1] Dr. J. Russell on *Prevention and Control of Infectious Diseases*, p. 70.

[2] *Sanitary Record*, Sept. 15, 1885.

[3] Mr. Cornish, in "Reports of Measures adopted for Sanitary Improvement in India," June 1872 to June 1873. (Blue-book.)

An outbreak of cholera at Delhi[1] in November 1871, illustrates the manner in which an epidemic may occasionally be started. A tanner of Delhi died on Nov. 19, and on Nov. 26 a feast was given, according to custom, in honour of the occasion. The tanners of the quarter were present in the house to the number of 400 or more, and partook of the feast. On the 28th several of them were seized with cholera. By Dec. 4, seventy had been attacked, of whom forty-three died. On investigation, it was discovered that the hot food had been spread for hours before being eaten on a mat, which lay upon the floor, and that upon this floor the man who died of cholera on Nov. 19 had been sick and purged. But for this discovery the outbreak would have been looked upon as mysterious.

There is much evidence to show that cholera is specially apt to break out when the subsoil water reaches either an unusually high or unusually low level, and when it fluctuates more than usual; but a good deal of course depends on the nature of the soil of the locality and its situation with regard to rivers, etc.[2] The cause of outbreak after the rains may frequently lie in the water of shallow wells, which have been filled by percolation through infected soil, in which the microbes would multiply exceedingly after the accession of the required moisture, and the cause of the occasional outbreaks when the wells are low might be either the increased proportion of microbes to the quantity of water carried into them, or else to any accidental con-

[1] "Reports," etc. Abstract of the Eighth Annual Report of the Sanitary Commissioner with the Government of India, 1871.

[2] *Ibid.* p. 86.

tamination by human agency which would easily render a small volume of water dangerous.

A very important improvement in the condition of wells would be to pave their immediate surroundings, to curb them with masonry, and to provide them where possible with pumps and covers to prevent pollution. But a still greater safeguard would be to build large cemented underground tanks, to be filled from roofs or specially-contrived clean surfaces in the rainy season, and to use these tanks for all drinking and cooking purposes. The water would thus be independent of the condition of the soil, and invariably pure.

Dr. Cunningham[1] states with regard to the importance of educating the people in sanitary matters—"A bare statement of the facts regarding the benefits which the inhabitants of Calcutta have derived from better drainage and a good water-supply would do more to advance sanitary progress than any theoretical disquisitions as to the causation of disease." The improvement in Calcutta's health may be gathered from the following table for the years 1865–71—

DEATHS FROM ZYMOTIC DISEASES.

1865	...	...	...	...	18,637.
1866	...	...	...	...	15,970.
1867	...	...	...	...	8,709.
1868	...	...	...	...	10,308.
1869	...	...	...	...	9,471.
1870	...	...	...	...	7,010.
1881	...	...	...	...	6,741.

A frequent cause of cholera may be the adulteration of milk, which is a common practice, with dirty water.

[1] "Reports," etc. Abstract of the Eighth Annual Report of the Sanitary Commissioner with the Government of India, 1871, p. 101.

The houses of milkmen and the cattle-sheds are hotbeds of filthiness.[1] Cows may possibly be the means of communicating cholera occasionally by their drinking infected water in dirty pools. Cattle for killing are sometimes even fed upon human excrement, and often on horse-dung.

The tank within the great temple of Madura is used and has been used by the people for hundreds of years as a bathing-place before presenting their offerings to their deity there, and on an average 200 bathe and wash their clothes there every day as a sacred duty.[2] The fœtid fluid in which they wade is a most disgusting compound, and the quantity of putrefiable organic matter was so great that the Sanitary Commissioner was unable to determine it by the permanganate of potash test. A draught of the water is used by the natives as a laxative, and dholl is soaked in it before cooking. According to the engineer, who wrote in 1871, cholera regularly appeared in the Chittera Festival, when crowds of people flocked to the temple.

In a Memorandum of the Army Sanitary Commission for the Province of Oudh, it is stated[3] that the country appears to be mainly low and flat with reference to rivers and natural outfalls. The consequence is, that the subsoil water-level rises considerably after rain. Even in the capital city, Lucknow, during heavy rain the water rose in the cemetery so fast that it was with difficulty graves could be made. The water stood unusually high in the neighbouring wells. At this very time cholera was committing havoc among Europeans

[1] "Reports," etc. Abstract of the Eighth Annual Report of the Sanitary Commissioner with the Government of India, 1871, p. 213.

[2] *Ibid.* p. 156. [3] *Ibid.* p. 222.

and natives living on this saturated subsoil. In Faizabad, cholera appears to be endemic. There can be no doubt that dampness is a potent determining condition of local cholera outbreaks. Dr. A. Cameron says, that having lately visited some of the villages which suffered most from the epidemic, he found in all of them "an utter want of cleanliness, the houses for the most part in ruins, heaps of filth lying in all directions, wells open to every kind of contamination, the water loaded with suspended impurities." The civil medical officer at Ratabgarh found the water three to four feet from the surface in cholera villages, and the well-water full of weeds, grass, and twigs. At various villages Dr. C. Cameron found them all more or less surrounded by jhills, which had overflowed and poured their impure water into wells, which had thus been rendered foul by human excrement and filth. In a hut attacked by cholera the people all lie about together, and the flooring, bedding, and clothes are allowed to remain contaminated. The police were actively engaged in distributing medicines, etc., and only two were attacked. They were supplied with good food and water as a rule. Owing to sanitary arrangements at fairs, there was no cholera at any of them, although very large numbers of people were assembled, and cholera prevailed in the Province.

In the Report of the Army Sanitary Commission of the Punjaub for 1871, the following recommendations were made for improving the water-supply—

(1) Selecting the best wells for use.

(2) Cleaning and deepening these wells where required, to increase and improve the supply, or digging fresh wells.

(3) In all cases where there is any risk of subsoil contamination of the water, the impure subsoil water should be cut off by casing the well-tube to a sufficient depth from the surface in concrete, and draining all waste water away from the well's mouth.

(4) Raising the tube of the well two or three feet above the level of the ground, providing suitable cover for the well, and means of drawing water by pumps or windlass, and iron buckets and chains.

In the Report of the Army Sanitary Commission on Madras,[1] it is stated with regard to that town, that the more unhealthy parts are those where the soil has become sodden with the filth of bygone generations, and where the air is polluted by gaseous emanations from sewers of indescribable foulness, and where the subsoil water consumed by the population has been tainted by the pollution of the earth.

In the same Report the improvement of the jails appears to have resulted in a diminution of mortality from between 93 and 124 per 1000, from 1861 to 1866, to an average of less than 40 between 1867 and 1871. In the improved central jails, the death-rate was 15, and in the old district jails 20·5, a "great sanitary victory," as Mr. Cornish describes it, and there were no deaths from cholera or small-pox.

Cholera, according to the Madras Commission, "has a horror of all kinds of purity and cleanliness."

In their Report on water-supply, they recommend for many places the sinking of deep wells, raising the water into tanks by steam, and distribution otherwise than by dipping. They recommend also the daily

[1] "Reports," etc. Abstract of the Eighth Annual Report of the Sanitary Commissioner with the Government of India, 1871, p. 234.

removal of excreta, or efficient drainage, and the subsoil drainage of town sites.

The progress of sanitation in England, especially the improvement of the water-supply, has greatly diminished the chances of cholera prevailing to any great extent, and the severity of epidemics successively diminished up to 1866, since which it has not succeeded in establishing itself at all. The epidemic of 1849 caused 53,293 deaths in England and Wales, that of 1854 caused 20,097, and that of 1866 caused 14,378.[1]

In 1853 the disease was spread through Russia, Norway, Sweden, and Denmark, and introduced from the Baltic ports of Germany to this country. Diffused by human communications, its most fatal ravages were clearly traced to the most crowded alleys of large old towns, impure air and water, and foul streams.[2]

"The very marked improvement in the health of the town of Calcutta which has characterized 1870, and which has been coincident with the introduction of a good water-supply, deserves special mention. Comparing the statistics of mortality with what they have been previously, it appears that in 1870 the deaths from cholera numbered only 1563, less than one-half of what they were in the year previous, and very little over one-half of what they were in the most favourable year of which there is any record."[3]

"Improved jails have a remarkable immunity from cholera when compared with others."[4]

[1] *Progress of Preventive Medicine.* Thorne Thorne.

[2] Report of the Royal Sanitary Commission, 1869.

[3] Report of Measures adopted for Sanitary Improvement in India, 1871-72. Blue-book, 1872, p. 103.

[4] *Ibid.* p. 217.

Dr. Cornish, Sanitary Commissioner of Madras, in a Report[1] on the movements of cholera in that Province, concludes that cholera almost always reaches the Province *viâ* Central India, and not by the shorter route along the Coromandel Coast; that epidemics generally occur about once in four or five years; that the S.W. winds do not retard the advance southwards, nor the N.E. winds hasten it, the period of time occupied by the invasion of Southern India being from six months to two years. It moves by preference among populations which have not been recently attacked. By the banks of rivers, in hollows generally, and along the base of mountain ranges facing an advancing epidemic, the disease has been very fatal. "When the water-supply has been practically pure, I have not found that cholera affected the people using such water, although the disease may have been epidemic in the locality." Mr. Cornish considers water but one channel, though an important one, through which cholera may spread. He gives a number of very striking instances of the comparative immunity of new jails, with good sanitary arrangements, from cholera at the time epidemic. The same immunity holds with regard to well-managed villages. A highly instructive instance is given incidentally with regard to the village of Puthian Puttur, in the Tinnevelly District. This village had been reported exempt from cholera, "cause unknown." Thereupon, Mr. Kearnes, a missionary who resided in the village, addressed a letter to the Chief Secretary, stating the reasons of exemption. When he took up his residence there, few villages suffered more

[1] Report of Measures adopted for Sanitary Improvement in India —Report by Surgeon Cornish, Sanitary Commissioner of Madras, 1870, p. 219.

from cholera and fever. Filthy channels, foul water draining from the surface into wells, disgusting yards of native houses, absence of trees, and fearfully large cholera mortality, set him about improving the place with the aid of the local officers. The wells were walled up above the ground-level, the channels improved and their contents applied to the land. Pools were filled up, and precautions taken to drain waste water away from the well's mouth. A system of cleansing was organized and practised; 700 trees were planted, and pains were taken to enlist the people in the protection of their own health; filth is never permitted to remain an instant in the public streets. The water is excellent. There is no cholera.

The Commission state that Mr. Cornish has shown the predisposing causes of cholera to be the same in the Madras Presidency as in other countries, namely—filth in and around dwellings, low damp locality, bad water, overcrowding, deficient or bad food, fatigue, and pilgrimages.

Cholera is most severe in the Central Provinces during the driest and hottest times of the year, when much of the water-supply becomes rapidly scanty and impure.[1] In the hot weather of 1869, when the country was suffering from severe drought, cholera raged with unexampled violence. The season of the year in which cholera shall prevail in a town or village is determined by the nature of its water-supply. If the supply is derived from rivers, streams, nalas, or excavations in the ground, it will prevail in the hot weather, not in the rains, after the rivers and streams have been flooded.

[1] Report by Surgeon Cornish, Sanitary Commissioner of Madras, 1870, p. 237.

If the supply is drawn from tanks or from small surface wells receiving the surface drainage of an inhabited area, cholera will prevail soon after the rains have set in. If the supply is drawn from deeper wells, cholera will reach its maximum of prevalence when the water in the wells approaches the surface of the ground; the extent to which cholera shall prevail in such localities depending in a great measure on the degree of porosity of the soil and subsoil. Dr. Townsend concludes that the choleraic influence is diffused by human intercourse, but that for the manifestation of the disease there must be a susceptibility in individuals to the action of the poison.

The Officer of Health reported[1] in 1871 with regard to Calcutta that the native portion of the city was still in a foul condition, and that the native villages were "without doubt permanent foci of dormant pestilence and malaria, which the slightest climatic influence may revive and diffuse."

The conditions which sometimes give rise to cholera and other diseases are well described by Mr. Whitwell concerning Kohat, a trans-Indus frontier station.[2] "The whole surface of the ground occupied by the military cantonment has, not very long ago, been occupied by human graves. In fact the whole place has been one huge graveyard for the adjoining native city. . . Pucka graves are plentifully scattered about, and are met with in the compounds of houses occupied by officers. On such soil we have built our hospitals, sunk our wells, and encamped our troops. The whole cantonment has been characterized as the 'most unhealthy' of the

[1] Report by Surgeon Cornish, Sanitary Commissioner of Madras, 1870, p. 247.

[2] *Ibid.* p. 248.

frontier stations. There are, in addition to the city, several villages scattered about in the vicinity, whose chief duty seems to consist in a persistent pollution of the water sources." The course of the water after leaving the spring is far from pleasant to contemplate. It "runs under the roots of a Peepal tree, continues its course through a graveyard crowded with graves, and in which burials still go on. From the time of its emergence to the termination in the reservoir, it is subject to constant and systematic pollution of the worst kind. The usual mode of obtaining water is for the bheesty, with his shoes on—never mind what filth has accumulated on them—to step down till the water reaches his knees, and then fill his mussick by immersion." In the jail prisoners were supplied from a well within the precincts. "It is a very significant fact that prisoners who used no other water but from this well entirely escaped the severe explosion of cholera from which the troops suffered." Mr. Whitwell notices the "dreadfully filthy" condition of carriers' water-bags as a frequent source of pollution. It is suggested by the Army Commission that the water be conveyed in earthenware drain-pipes laid in concrete, wherever liability to pollution exists. No water should be drawn from the distributing tanks, except by taps or pumps, and the tanks should be closed, but ventilated.

Of the water-supply of Subathoo, Dr. May reports[1] that it is futile to hope for a good supply till the whole system of conservancy has been overhauled and re-modelled. He mentions a tank which derives its water from under a village, described as being about the

[1] Report by Surgeon Cornish, Sanitary Commissioner of Madras, 1870, p. 257.

dirtiest he has ever seen. Of another source he says—"The whole hill-side from which it springs has been made use of as a kind of open-air latrine, and smells terribly." In the case of Dugshai we have an example of conditions "common to all hill-stations," namely, water led away in open cuts, becoming contaminated by filth, and then received into an open tank, the vicinity of which is filthy from the manure of mules employed in carrying water. The Commission finally suggest that "a few engineering rules for ensuring a pure water-supply at every present and future hill-station, to be carried out on some one's personal responsibility, might possibly put a speedy end to the present dangerous condition of nearly every existing supply."

Children sometimes get bad bowel-complaints and even cholera through contaminated milk, for "native cowkeepers are sure to add water to the milk, often from the nearest supply, however impure."[1]

If men, especially men wearied by travel and improperly fed, pass through a place where cholera prevails, they are very liable to be attacked, and that in a larger proportion than the ordinary residents.[2]

Mr. Christie, in a paper[3] read before the Sanitary Institute, maintained that the chief mode of propagation of cholera is by water polluted by the excreta of a cholera patient. The pilgrims at Mecca in 1865 were estimated at about 100,000. Previous to the celebration of the rites, each pilgrim, standing at the side of the well, has a bucket of the water poured over him,

[1] *Rules for Preserving Health in India*, p. 255.

[2] Eighteenth Annual Report of the Sanitary Commissioner with the Government of India, 1882, p. 126.

[3] *Trans. Sanit. Inst.*, 1883-4.

and he drinks as much of the water as he can, the water poured over him passing back into the well. "Within six days after these ablutions, and the drinking of the water of the Zem-Zem, the streets of Mecca and its mosques, the twelve miles of road lying between the city and Mount Arafat, were cumbered with the dead." The water was analyzed by Professor Frankland, and found to be of the most abominable character. The character of the water, however, is not sufficient to give cholera; it is the introduction of the cholera germ to filth in which it thrives which is the cause of irregular periodical outbreaks. "If there is one thing more than another as to which I am thoroughly convinced, it is that cholera is conveyed by man to man, not necessarily, nor even usually immediately, but mediately, through excretal matter. Pandemic waves, air-borne influences, choleraic blasts, atmospheric and telluric conditions, subtle miasms and influences, the variations in the ground-water, neither singly nor combined, can account for the geographical distribution of the great cholera epidemic which prevailed in Asia, Africa, and Europe from 1864 till 1872. With steady march, it passed along lines of human intercourse, attacking the inhabitants of cities and towns who were exposed to all sorts of sanitary conditions. . . . The best plan is to render an epidemic of cholera impossible. This can be done with comparative ease, the only difficulty being in moving our Government and Local Authorities. The public measures for the prevention of cholera are measures equally necessary for the promotion of public health, and I may add for the promotion of public morality." Besides a pure water-supply, cleanliness "means the immediate removal from our dwellings, and from our surroundings, of all decomposing matter, and the immediate destruction of it by fire after it has been removed. The actual outbreak of epidemics can only be encountered by the management of first cases of illness, by the isolation of cases, and the absolute destruction of all excretal matter. . . . The really important international question as to cholera consists in an investigation as to the sanitary service of nations." As to endemic cholera in India, it is essential that people should be induced to give up the practice of bathing and washing their clothes in tanks from which they draw their drinking-water.

Mr. Jones, of Madras, noticed that in an outbreak of cholera which occurred during his stay in that town, the disease attacked chiefly the washermen, showing that it was conveyed by the clothing as well as by the person.

Mr. Harrison put the manner of spread of cholera concisely in stating that it seemed to be conveyed by dirty men to dirty places. Prevention of cholera, as of other epidemic diseases, depended on cleanliness—clean men, air, earth, and water.

"All independent and scientific students of the subject in Europe and America are now agreed that the vehicle of contagion is contained in the evacuations, and carried as fomites by soiled clothing, etc., while persons suffering from the disease in unrecognized and mild forms infect the soil and water of places through which they pass. The time of incubation is from one to two days, four being an ample outside limit. Cholera always follows the great trade routes, etc., and at a speed proportionate to the rate of travel. The outbreak in Spain in 1890 was a recrudescence of the epidemic of 1884-5, caused by excavations in infected ground."[1]

Sir William Moore gave his experience of an outbreak at Aden following the unloading of cargo which was proved to have been soiled by cholera excreta at Bombay, the crew remaining healthy.

Cholera on board ships on the Hooghly was traced by Dr. Simpson to an infected milk-supply.

The massing of people at great fairs like those of India, Mecca, Nijni-Novgorod, and others, has contributed very largely to the origin, and the dispersion of the people to the spread, of cholera in Asia and Europe.

Through the evidence of conscientious workers and observers in Germany, Great Britain, and France, most of those who have studied the subject carefully have come to the conclusion that cholera is a parasitic disease, travelling along the ordinary lines of commerce by railways, caravans, and ships, from the regions where it is endemic to those centres of religion and trade, which, by their imperfect sanitary arrangements, by the want of cleanliness of their inhabitants, by meteorological conditions, and on account of bad water-supply, are ready for its reception and propagation.[2]

The general result of extended observations by various investigators on the comma bacillus is that this organism must be looked upon as the actual cause of cholera.

The comma bacillus is regarded as belonging to the spirilla, has an average length of 1·5 μ, and a

[1] *Cholera Epidemics*, by Dr. Ed. F. Willoughby. Paper read before Epidemiological Society, March 18, 1891.

[2] *Bacteria and their Products.* Woodhead. 1891.

thickness of 0·5 μ. It grows well on potatoes when the temperature of the room reaches 30° or 35° C. The cultures from different cholera epidemics differ slightly in appearance, so that a skilled observer can distinguish the bacilli of each epidemic. Milk is an exceedingly good nutrient medium; this explains the virulence of certain outbreaks through contaminated milk. The bacilli feed well and multiply on a great variety of organic products. In dejecta sprinkled on moist soil or linen they multiply at an enormous rate. The danger of working, without observing all precautions, on the cholera bacillus, is illustrated by the case of a doctor who had been for eight days engaged on the subject in Berlin; he was attacked with cholera, the only case in Germany, and the bacillus was found present; the patient recovered. He had been making cultivations of the bacillus, and must accidentally have swallowed sufficient to cause infection in the weak state of digestion which happened to affect him at the time of exposure.

Experiments on the cholera bacillus throw much light on the reasons of the increased infectiousness of cholera excreta, etc., after cultivation for some hours or days outside the body. For the reasons of this increased power, Mr. Woodhead's very instructive volume, just issued, may be consulted.

As far as prevention is concerned, it is important to note that dryness, the rapid and complete removal of stagnant and upper ground-water, and pure water-supply, are essential; but Koch considers that the ways in which cholera can spread itself are extremely varied, and that almost every place has its own peculiarities, which have to be thoroughly investigated, and rules have to be drawn up accordingly. He contends that cholera is endemic in the Ganges, because there is a complete chain of cases from one year's end to the other by which the infection is handed on. Hueppe, however, considers that the bacillus can maintain a distinct saprophytic existence. According to Nicati and Rietsch, cholera bacilli were found alive eighty-one days after they had been placed in the harbour water of Marseilles.

"One can easily imagine," says Koch, "that in superficial layers of earth, marshes, and so forth, they may find conditions in which they can exist preserved from death for five months or even longer, just as well or even better than on our moist agar jelly." In India, in the regions where cholera is endemic, the wells as a rule are merely surface tanks into which sewage and surface water may drain, and are often close to cesspools.

With all the improvements in the drainage system and water-supply of Lower Bengal, cholera has not diminished more than 60 per cent. According to Flügge, cleanliness is very highly important in the prophylaxis of cholera. The more carefully the hands are cleansed, and the articles of food prepared (besides avoiding contamination of soil and water), the more will the paths of spread of the infection be diminished. The amount of dirt which finds its way to food and water is not contemptible, and in China vegetables are regularly watered with excrementitious matter. In Marseilles the market-women are in the habit of sprinkling the vegetables exposed for sale with water from the street gutter, into which, in time of cholera, comma bacilli have been proved constantly to make their way.

Pilgrimages, fairs, carousals, and assemblages of many persons subjected to insanitary conditions and digestive disturbance give potent opportunities for the outbreak and spread of cholera.

For preventing the propagation of this disease the inspection of all ships coming from cholera-stricken places, careful isolation of all patients, and disinfection of all clothing, feeding utensils, etc., mixing the dejecta with large quantities of carbolic acid, concentrated hydrochloric acid, or strong corrosive sublimate solution, are strongly insisted on by the bacteriologist.[1] Rooms should be thoroughly dried and aired. All excesses of eating and drinking, and disturbances of digestion, are favourable to the onset of cholera.

The Venerable D. S. Govett, Archdeacon of Gibraltar, wrote recently[2] to the Secretary of the Sailors' and Firemen's Union, calling the attention of the committee to the "hundreds of cases of cholera, typhoid fever, and dysentery" caused every year by neglect to provide filters for drinking-water on board ship.

In India the surface of the ground in and around villages and towns is covered with filth of every kind.[3] Streams are used as receptacles for excrement, the tanks are used for ablution. Wells are polluted by a foul subsoil and fouler adjacent surface, and they, as well as tanks, frequently formed the receptacles for dead bodies. Cattle were kept in the most filthy condition, and cows fed largely on dung. At Meean Meer two wells were only 118 feet distant from cesspits from

[1] *Bacteria and their Products*, p. 191.

[2] See *Daily Chronicle*, Oct. 28, 1891.

[3] Douglas Galton, "Address on Health," *Trans. Social Science Assoc.*, 1873.

50 to 60 feet deep, which contained the accumulated filth of eleven years. In 1861 an epidemic of cholera destroyed 24½ per cent. of the population. At Simla the water-sources were in ravines which served as surface drains and sewers, and were hourly liable to disgusting pollution. One source was surrounded with a compost of fæcal matter, bones, and refuse, which was being gradually worn away by the current, and this water was distributed as usual in dirty sheepskins. These are only instances of conditions which were quite common, and eminently favourable to the spread of cholera.

According to Parkes,[1] cholera is portable from place to place by a person in all stages of the disease, in the premonitory diarrhœa, in the midst of the attack, and in convalescence. It may also be communicated to healthy persons by others coming from infected districts, if no precautions are taken. Cholera so easily evades cordons and quarantine, or rather these defences are so easily broken through by human agency, and the supposed interests of commerce, that such measures are not very successful except in the case of remote inland villages or islands. Where circumstances are favourable, however, good quarantine combined with constant hygienic measures and strict isolation may be very successful even on the mainland. This was shown in Algeria and in the United States in 1867. The isolation of the earliest cases and diarrhœal attacks, and the disinfection of discharges and linen, are of the greatest effect. The spread of cholera by the winds in India, which is believed occasionally to occur, has been ascribed to the custom of throwing all the evacuations on the

[1] *Practical Hygiene*, p. 478.

ground, where they are dried and scattered as dust by the air. It is always of vital importance to treat these discharges with the strongest disinfectants, and to bury or burn them. Suspected water-supplies for drinking should be examined, and all drinking-water boiled and filtered. With regard to predisposition to cholera, little has been made out except that (1) diarrhœa, and (2) great fatigue, predispose, but feebleness of health does not predispose. It has been made a rule in the army that any man affected with the slightest diarrhœa should report himself. The incubative stage of cholera may be from ten or twelve to twenty days.

Cholera appears to have frequently arisen among troops marching by road owing to carelessness as to the sources of supply of water by native puckally bullock-carts; for the native watermen draw from any tank by the roadside, polluted in the usual way by travellers.[1] When the camp is reached, an advance party of natives frequently pollute the tank before it can be protected as a source for the troops, and many facilities are thus given for the propagation of disease. Carts provided with approved water and filters should be kept up with a marching column, and in this way, or better, with arrangements for boiling the water supplied to the troops, much illness would be prevented.

Mr. Scriven has given an instance of the seizure by cholera of two persons attending a cholera-stricken child, one through kissing the child, and another through wiping her mouth with a handkerchief which had been used on the child's face.

The following description of a cholera-den in Cal-

[1] *Trans. of the Society of Medical Officers of Health.* Brigade-Surgeon E. Nicholson.

cutta demonstrates the condition in which a pestilence finds its proper food[1]—"The drainage is both underground and surface, free but dirty. The dwelling is badly ventilated and overcrowded; inhabited by about forty-five or fifty persons. Five persons used to live in the same room with the deceased, which is about 200 cubic feet in capacity, and has only two small windows on the south; but quite blocked up on the other three sides. The privy is of masonry, and foul, and its vault is very dirty; very offensive fæcal smell is constantly emanating from the privy, and could be felt from the yard. Water and washings fall into very filthy and foul kutcha-pit in the yard; putrefaction was going on, and bubbles of offensive gas were seen to be evolved. Well in compound, liable to pollution, used for washing." Great improvements are possible in Calcutta by paving, draining, cleaning, and improved water-supply, and by ventilation of places in which cases of cholera or typhoid have occurred, in order that defects may be remedied.

It may be mentioned that cholera was worshipped in Calcutta, and a temple containing the idols of the goddesses of small-pox and cholera was frequented largely by pilgrims and others, especially in periods of epidemic.

Bengal has been stated to be the area in which cholera is endemic, whence the plagues arise which destroy multitudes over a large part of the surface of the globe, and it was to Bengal that the epidemic of 1832 in England owed its origin and cultivation.[2] Cholera prevailed in Lower Bengal in 1826; in Bombay,

[1] *Sanitary Record*, August 15, 1888.
[2] Macnamara, *History of Asiatic Cholera*.

Scinde, and the Punjaub in 1827; in Khiva, Herat, and Teheran in 1829; also at Bokhara. Khiva and Bokhara did a considerable trade with Orenburg, and this, the first place in Europe, was attacked August 26, 1829. Meanwhile cholera had advanced upon Russia from Persia, *vià* the Caspian Sea. Astrakhan was affected in August 1830. Thence the cholera marched over Russia. In June 1831 it reached St. Petersburg; in August, Berlin and Vienna; towards the end of the year it prevailed in England. Some warships lying in the Medway, where some vessels from Riga were in quarantine, appear to have felt touches of cholera in July and August. In August, apparently, it had been imported to Sunderland. Then it cropped up in various towns communicating largely with the Continent. Having made its way over Ireland it re-appeared in England at Hull, York, Leeds, and other large towns before the close of August 1832.

An emigrant ship conveyed the cholera from Dublin to Quebec in June 1832. On June 23 it had reached New York, and the whole of the United States was affected before the close of the year.

The progress of the epidemic of 1849 was not unlike that of its predecessor in its principal features, appearing first at Tiflis, then Astrakhan, spreading over Russia, and in 1848 reaching London, *vià* Hamburg. Hull was the worst affected place of English towns, and Leeds, North Shields, Sunderland, and the mining districts of Wales suffered severely.

In 1848, the first case of cholera in Scotland occurred in the same house and within a few feet of the very spot whence the previous epidemic of 1832 had started. At Pollockshaws it arose in the same bed and same room as in 1832; at Bermondsey close to the same ditch as in 1832.[1]

In December 1848 it was conveyed by emigrant ships from Germany to America.

In 1853, cholera first made its appearance on the Tyne, while the epidemic prevailed in Northern Europe. By the 16th of December it had caused a fatality of 10,675 in London.

In 1865, pilgrim-ships from Jeddah conveyed the infection of a great outbreak at Mecca to Suez, and thence it was imported to Alexandria. In less than three months 60,000 persons had been killed by it in Egypt. It was apparently brought to Southampton in July 1865 by a ship from Alexandria, and to Bristol from Rotterdam; also to Liverpool by foreign emigrants. From the Mersey it was imported to America.

The following places have hitherto remained free from Asiatic cholera—Australia, New Zealand, most of the islands of the South Pacific, the Cape of Good Hope and adjoining colonies, the islands of St. Helena, Ascension, the Azores, Bermuda, Iceland, the Faroe, Orkney, and Shetland Islands, and the West Coast of South America.

It will be noted that the greatest security against cholera is isolation—that is, distance from persons or goods which have been in proximity to cholera cases. But in populous countries communication is constant, perfect isolation becomes impracticable, and happily almost complete security may be attained by measures of cleanliness, disinfection of merchandise, segregation of suspected persons, careful provision for pure supplies of water, and the utmost attention to drains, cesspits,

[1] *Trans. Sanit. Inst.*, 1885-6, p. 354.

ashpits, dustheaps, and decaying animal and vegetable matter. But the building up of defences against cholera and other epidemics is a matter of time, and involves municipal or national works for supplying good water, good drainage, good building, thorough scavenging, and a diffusion of some slight knowledge of the causes of disease among the population.

The original home of the cholera microbe being the upper part of the delta of the Ganges, and neighbouring parts being largely subject to infection, it becomes the first object to render this district less favourable to the development of the organism. The stagnant water on each side of the river is foul with every sort of filth and decaying matter, and the land is almost on the level of the water, or even under water. It appears to be of the greatest importance—first, to reduce the amount of organic débris allowed to be cast into the river; secondly, to drain inhabited areas as thoroughly as possible; thirdly, to insure good supplies of water, and, in all times of threatened epidemic, to insist on the boiling of all drinking-water; fourthly, to demolish the worst houses and streets, to open out towns and villages, drain, and keep them in a cleaner condition; fifthly, to arrest at once the first start of cholera by a sanitary police, isolating cases and inquiring into their probable source; sixthly, to keep a close watch on the movements of pilgrims.

When once cholera has proceeded on its devastating course, the most effectual means of rendering it innocuous, and depriving it of food, in places hitherto unaffected, is to watch with the greatest care the movements of persons and goods from infected places; to isolate, disinfect, and detain them; to cleanse every suspected article, ship, or house; to put the town or district or the whole country into as sanitary a condition as possible, by closing foul wells and water-supplies, promptly removing all decaying organic matter, keeping cesspools where they exist from overflowing, and keeping all water for drinking at as low a temperature as possible. It is very important to avoid all known causes of diarrhœa, which, being often due to a kind of catarrh of the stomach, presents a favourable opportunity for the attack of the cholera microbe. Dr. Farr has said that "to arrest diarrhœa is to prevent cholera." Probably there are two reasons for the frequent existence of diarrhœa before cholera. Firstly, the high temperature and pollution of water are conditions for the existence of both the diarrhœa and the cholera microbe; and thus a water already causing diarrhœa is likely to be infected with the cause of cholera. Secondly, the irritation and weakening of the digestive organs allow the invading host of cholera to attack without effectual resistance. The following points, insisted on by high authorities, deserve particular attention[1]—Damp, dirty, overcrowded houses, predispose their inmates to attack. Light and plenty of air are highly important. Drains, pipes, sinks, rain-water spouts and closets should be kept in good order. All sources of cold and indigestion should be avoided, also excesses of eating, drinking, and exercise. It is important never to eat with unwashed hands, when cholera or diarrhœa are near. Milk coming from places affected with diarrhœa or cholera should be avoided. It is safest to boil both milk and water when these diseases are about. Clearly, many of these rules are

[1] See *Pall Mall Gazette*, Report on Cholera.

beyond the scope of public Sanitary Authorities, except in so far as they can distribute them in their district for the use of all adult persons, in time of peril.

The large part taken by infected water in the propagation of cholera is established beyond all question by the inquiries of Dr. Snow, who in 1854 traced a very extensive outbreak in London to a certain well which had been contaminated by the infiltration of discharges from a child suffering from apparent diarrhœa. Even individuals living at a distance who had drunk water from the same well, having the water conveyed to them, were attacked. In Newcastle the supply and stoppage of a certain water-supply diluted with water from the Tyne, exactly coincided with the spread and cessation of cholera.

A very valuable Report, comprising a large store of useful facts and fruitful theory, has quite recently been published by Dr. Edward Shakespeare, United States Commissioner. He quotes Dr. Mahé's estimate of the number of victims of the cholera epidemic of 1884-7, in Europe, at 250,000. It is concluded that, without exception, these visitations of cholera have been traced back to India as their place of origin, and that they have followed the course of trade, of travellers, or of armies, moving either by land or sea. That its spread is universally associated with contaminated water, filthy habits, and bad personal and domestic hygiene. That the presence of Koch's comma bacillus is absolutely diagnostic of Asiatic cholera.

The *national* control of maritime quarantine is strongly advocated as a necessity, in preference to independent quarantine methods provided by sea-board States and cities. Dr. Shakespeare regards it as improbable that the air conveys the infection of cholera at all, and as certain that the air never conveys it long distances: the poisonous material enters the system by the stomach. The normal acid of the stomach may destroy the bacillus, and there is reason to believe that drinking water between meals may be especially dangerous, as at such times there is often a neutral reaction of the gastric contents. He maintains that even the poor attempts to establish land quarantines and *cordons sanitaires* have been of much benefit in at least impeding the onward course of an epidemic. He insists on the extreme care necessary in permitting "free pratique" to ships on declarations made. The earliest cases in any place should be attended by physicians and nurses paid for at the public expense, and all persons living in infected houses should be isolated for five days. The practical instructions of the Sanitary Department of Bombay, issued in 1883, are considered most excellent and valuable.[1]

As regards cholera and its prevention, we may fairly conclude that it is very largely preventable, even in its original seat, and still more extinguishable in secondary foci; that the microbe, of which hundreds of millions may proceed from a single case, is carried from place to place by man and infected goods, especially clothing; that it multiplies readily in foul water to which it may have access; also in milk; in damp and dirty places, contaminated streams and rivers, and exposed decaying organic matter at a suitable degree of moisture and temperature; that thus the entrance of one sufferer

[1] Report on Cholera in Europe and India. By Edward O. Shakespeare, A.M., M.D., Ph.D., U.S. Commissioner.

from cholera to an unaffected district may result, in a short time, if his discharges, clothing, etc. are not carefully disinfected or burnt, in the deposition, growth, and dissemination of immense multitudes of the microbe; that only a certain proportion of the inhabitants are easily infected, and that in most persons an entrance to the stomach of large numbers of microbes is necessary to cause an attack. Thus the mere breathing of moderately infected air is not usually sufficient to produce the disease, though doubtless some organisms are swallowed. A weakened condition of the digestion is favourable to the survival and increase of the microbes.

Cholera can be, and has been, arrested and prevented in Europe by measures of segregation, isolation, disinfection, cleanliness, scavenging, pure water supply, and, in time of epidemic or danger, boiling or cooking of all articles of food and drink. These measures would also have the effect of preventing much mortality from other diseases arising from similar conditions. Wherever tried, they have absolutely excluded cholera, and raised the health of the community.

CEREBRO-SPINAL MENINGITIS.

THE origin of this very severe disease is unknown, but has been ascribed to the use of bread made from diseased grain. It is widely distributed in the temperate zone, and in Iceland has usually prevailed in winter and early spring. Robust males between fifteen and thirty, and especially army recruits, are its favourite victims. Exhaustion by physical exercises and cold weather, predispose.

The disease does not appear to have been known before 1837, when it prevailed with great virulence in various parts of France. An extensive outbreak occurred in North Germany in 1863, 1864, and 1865, with great mortality. A series of epidemics have occurred in America. The disease has sometimes been mistaken for typhus. Black blotches appear on the skin, and there is severe mental disturbance.

Prevention of overcrowding and care for the purity of food and drink appear to be the most hopeful methods of exterminating this strange disease. The occurrence of both sporadic and epidemic outbreaks seems to show that conditions of overcrowding combined with exhaustion or a peculiar condition of the blood are the factors, in the presence of a particular microbe or fungus, which determine an attack. The diplococcus pneumoniae has been found in patients in this disease. Prompt isolation, disinfection, and antiseptic washes for those exposed to it may arrest its spread.

CONSUMPTION.

According to Dr. Theodore Williams,[1] the predisposing and general causes of phthisis are family predisposition; local inflammations, etc.; various debilitating diseases; bad ventilation; a hot and moist air; dampness of soil and houses; constant inhalation of particles of flint, iron, coal, hard clay, stone, cotton, flax, straw, etc.; and infection. Certain experiments of Dr. Burdon Sanderson seem to point to the conclusion that tuberculosis is closely associated with pyæmia, and may arise from the same causes; "cases of acute tuberculosis closely resemble those of pyæmia in their symptoms and course." The evidence of the Brompton Hospital negatives the idea of a contagion such as is present in small-pox or scarlet fever, and the percentage of acquired phthisis in the staff has been less than that of most general hospitals. We have here another piece of evidence, such as has been noted in cholera hospitals, of the power of hygienic method and cleanliness to overcome infective influences.

The influence of town air and town life in increasing the prevalence of respiratory diseases is strikingly shown by the mortality in that part of Surrey included in the

[1] Quain's Dictionary.

metropolitan area compared with rural Surrey.[1] In 1877, the population of metropolitan Surrey was 742,155, the deaths from these diseases 3695; the population of extra-metropolitan Surrey 365,279, the deaths 932, or little more than half as many proportionally as in London.

"It is the small houses" (in Glasgow), says Dr. Russell,[2] "which produce the high death-rate. They give to that death-rate the striking characteristics of an enormous proportion of deaths in childhood, and of deaths from diseases of the lungs at all ages. . . . Of all the children who die in Glasgow before they complete their fifth year, 32 per cent. die in houses of one apartment, and not 2 per cent. in houses of five apartments and upwards."

The tubercle bacillus, discovered and cultivated by Koch in 1883, is usually about 1·5 μ to 3·5 μ in length, slightly curved, and non-mobile. It may, in certain conditions, produce spores. It was grown by Koch on solidified blood serum. The organisms in human and bovine tuberculosis are morphologically identical, but are not altogether similar in their behaviour and in their pathogenic characteristics. Tubercle bacilli from a human patient will set up acute general tuberculosis in the cow, while those taken from a case of bovine tuberculosis or perlsucht, reproduce that form of the disease. Tuberculosis has broken out most virulently at a country place among fowls which happened to have had access to and eaten the sputum of a phthisical patient who had come to live at the farm.[3] Experiment

[1] See Registrar-General's Reports. [2] *Life in One Room.* 1888.

[3] For a similar case, in which a fowl became infected, and afterwards by being eaten half-cooked infected a person, see Lamallarée, *Gazette Médicale de Paris*, 1886. No. 32.

has given similar results. A dog even is known to have died of the disease through exactly similar means.[1]

Galtier found that maceration, the presence of putrefaction, intermittent freezing and melting, did not interfere with the transmission of the disease through the bacilli exposed to these influences outside the body.

The bacilli can be cultivated outside the animal body by supplying the necessary food and by keeping them in an incubator with careful regulation of the temperature.[2] The isolated bacillus produces tuberculosis when inoculated into rabbits, guinea-pigs, and monkeys.

A systematic examination was made by Cornet of the dust of rooms where phthisical and non-phthisical cases were treated.[3] He discovered that the bacilli are not only exhaled, but are contained in very considerable numbers in the dried sputum obtained from handkerchiefs, bed-linen, and on the walls and floors contaminated by phthisical sputum. Even in streets and open spaces frequented by patients he found the bacilli. In no cases did he consider the experiments complete unless the dust, when inoculated into animals, produced the disease.

It is easy to see how infection may take place, now that we are in possession of these facts. The predisposing cause of consumption is tissue weakness, whether as the result of illness, or of some irritant, or congenital. The conveying medium is usually foul,

[1] *Public Health,* July 1889 ; *Veterinary Journal,* vol. xxviii. No. 168. Mr. A. Peters, M.R.C.V.S., Boston, U.S.

[2] *Sanitary Record,* May 15, 1891. Prof. Crookshank.

[3] *Zeitschrift für Hygien,* 1889. *Ueber Tuberculose,* Leipzig, 1890. See also *Bacteria and their Products.* Woodhead. 1891.

rebreathed air. The actual excitant of disease is the bacillus.

In Germany, perfect cleanliness in the treatment of phthisical patients is looked upon as absolutely essential. Pocket-handkerchiefs and bed-linen used by them are most carefully sterilized by means of bichloride of mercury, hot air, steam, or other germicidal agents; they are strongly enjoined not to expectorate except into receptacles specially made for the purpose, which are portable and easily cleaned.

To kill the bacilli, nothing is so efficient as boiling water or steam at a high temperature. "All disinfection should be as carefully carried out when a phthisical patient leaves a room or ward as if a case of scarlet fever had been treated there; the walls, floor, and even the roof should be thoroughly washed and disinfected by means of hot water and lime." No patient should be allowed to expectorate on the floor. Spittoons which can be easily boiled in water should be used. During the time that corridors, steps, and rooms are being cleaned and disinfected, they should be kept quite moist, in order that as little dust as possible may arise from the cleaning operations. No room should be used until thoroughly disinfected; the bedding and curtains should be well boiled, blankets steamed, mattresses disinfected, furniture washed with soap and water, carpets and upholstering thoroughly beaten in the open air, etc. In San Remo all these measures have been brought under the notice of hotel-keepers.

According to Prof. Fleming, mankind has the aptitude to receive anthrax, rabies, foot-and-mouth disease, glanders, cow-pox, horse-pox, diphtheria, and in all probability tuberculosis, not to mention the reception of entozoa and epizoa, entophytes and epiphytes, which give rise to morbid conditions, often of a most serious nature.

M. Chauveau, of the Lyons Veterinary School, has declared that the infectious nature of tuberculosis is no longer disputable since the works of Villemin, Koch, and others. "The researches of the Lyons school have placed the identity of human and bovine tuberculosis beyond a doubt."

Experiments made by Gerlach, Principal of the Hanover Veterinary School, showed conclusively the communicability of the disease to various species of animals.

The veterinarians Harms, Günther, Bollinger, Bagge, Zurn, Semmer, St. Cyr, Jolin, Leisering, and others, reached the same conclusions.

Toussaint showed that flesh and milk were infective to animals. At the Congress on Tuberculosis in Paris in 1888 it was resolved—"That it is necessary to print simple instructions, which are to be distributed in all cities and villages, and in which are contained the methods to prevent tubercular infection by alimentation, particularly by milk, and the manner of destroying the virulent qualities of the germs contained in the sputa, linen, beds, etc. of consumptive patients. That cow-houses must especially be placed under the watch of an inspector, etc. All meat and milk of tubercular animals were recommended to be destroyed. That tuberculosis be inscribed in all the sanitary laws of the world as a contagious disease, necessitating special prophylactic measures."[1]

It is said that in England fifteen to twenty per cent. of all cows are affected with the disease.[2] In

[1] State Board of Health, New Jersey. Report, 1888.

[2] This estimate is probably above the true percentage.

the United States, the proportion is probably less than this in the country, but about equal to it in the towns. "If only city dairies could be properly cared for, we would soon diminish tuberculosis and other diseases." . . . "There are at least fifteen diseases of men and animals in which relationship and probable interchangeability are claimed."

From the history of consumption thus far known, three propositions may be formulated[1]—1. That the bacillus tuberculosis is the cause of the disease. 2. That the disease, when developed after the first years of childhood, is not inherited, but acquired. 3. That the disease is strictly preventable.

The preventability being acknowledged, an imperative duty is cast upon the medical profession. The true and intelligent physician will use every rational and scientific means in his power for the prevention and restriction of disease. In order that efficient work may be done in the prevention of consumption, the people must themselves have an understanding of its nature. The simple assertion that the disease is communicable is not sufficient, for in many families, who have no definite understanding of the term, there would be constant fear of infection, which would have a very detrimental effect. They ought rather to be taught the exact and definite channels through which the infection may be received, and the most efficient methods of avoiding it. A consumptive having a reasonable understanding of the nature of his disease, and who is discreet and careful in his habits, need not endanger his associates. The following may be stated as the chief

[1] State Board of Health, New Hampshire, U.S. Report, 1889. By Irving A. Watson.

requirements to be urged upon the public, and they are simple rules which a physician can readily teach in his own community.

1. That the greatest danger of infection is from the sputa of the consumptive. For this reason, when confined to the house, a spit-cup or spittoon should be used, and when upon the street a handkerchief to receive the expectorations. The spit-cup and spittoon might preferably contain a disinfectant, but if these vessels are frequently and thoroughly cleansed with boiling water, disinfectants are not an absolute necessity. The handkerchief used should be immersed in boiling water at least daily, *before the sputum has become dried.* 2. No person should occupy a sleeping-room with another who has tuberculosis. 3. The eating utensils of a consumptive should be washed in boiling water, and care should be taken that the same glasses, spoons, etc. are not, before being washed, used by children and others. The patient should avoid kissing others. 4. The dejections should be thoroughly disinfected in cases where the bowels are affected. 5. Perfect cleanliness of the apartments should be urged in all cases. The bed-linen, towels, etc. should be very frequently put through the operations of the laundry, while the walls should be frequently cleansed and dressed anew. In fact the whole question of restriction may be expressed in the one word "cleanliness."

Under a law recently enacted in this State, the local authorities have full powers to destroy tuberculous cattle and reimburse the owners. The danger of tuberculous meat and milk, especially milk, should be realized by the public.

Tuberculosis, or consumption, has destroyed and is destroying more lives than any other disease known to mankind. In New Hampshire, the deaths from the several diseases named were as follows in the years 1884 - 1888 :—Consumption, 4039 ; diphtheria and croup, 983 ; typhoid, 750 ; scarlatina, 187 ; measles, 160 ; whooping-cough, 109 ; small-pox, 2. But a single death from small-pox causes more general alarm than a thousand from consumption.

The mortality from consumption and susceptibility to it are great at all ages.

The State Board of Health of Maine recently issued a circular on the prevention of consumption, of which the following are some of the principal points—

The source of infection is twofold : From tuberculous animals to man, and from one human being to another. The use of tuberculous flesh of animals, and especially milk from tuberculous cows, is dangerous. Many infants die from various tubercular diseases ; and it is now believed, with much probability, that these diseases are very frequently derived from tuberculous milk. The greatest source of infection is consumptive human beings ; but by intelligent care, the ways in which this contagion is disseminated may be controlled. It has long been known that tuberculosis may be communicated to animals (experimentally) by feeding them with tuberculous matter, by injecting it into their tissues, or by causing them to breathe air into which tuberculous sputum had been atomized. More recently, since the discovery of the tubercle bacillus, it has been found that the bacilli may be cultivated upon artificial media ; and that when thus cultivated and free from all other matter which might possibly be infective, tuberculosis may be conveyed to animals in the ways which have been mentioned above. The expectoration of a consumptive patient spit upon floors, carpets, pocket-handkerchiefs, or clothing, becomes dried and pulverized, and, floated in the air, still contains the infectious germs, and cannot be inhaled without great danger. The breath of the consumptive patient, in well-ventilated rooms, may be considered harmless. Spittoons should be always used, and cleansed often with boiling water and potash soap. When the house has a drainage system, the contents may be poured down the water-closet or slop-hopper; when it has not, they should be buried in ground which will not be turned up soon, at a safe distance. It should not be thrown on manure-heaps, or on the surface, or near wells. Cheap wooden and pasteboard spit-cups are on the market, one of which may be burned daily, or oftener, with its contents. The floors, woodwork, and furniture of rooms in which patients stay should be wiped with a damp cloth, not dusted in the usual way. All bed and personal clothing should be boiled separately. When there is any doubt as to the health of cows supplying milk, the milk should be boiled. Thorough cooking will remove danger from flesh meat. The habitual breathing of pure air is most important to all.

The many experiments of Johne gave the following results[1]—

Of animals fed with tuberculous matter, thirty-five per cent. became infected. Of animals fed with flesh, not apparently tuberculous, of tuberculous animals, seventeen per cent. became infected.

One ox gives 280 kilos. of beef; this *could* infect 7280 guinea-pigs; but in practice, and if cooked, about

[1] *Les Virus.* Arloing. 1891.

620. The tuberculous oxen seized in Paris in 1888 could have infected 207,700 guinea-pigs.

There is a form of tuberculosis in the ox, in which the microbe is diffused in the blood. The flesh in these cases is highly dangerous.

The Congress on Tuberculosis in Paris (1888) passed, minus three votes, a resolution that there is need for the total destruction of all flesh derived from tuberculous animals. This applies to pigs as well as oxen.

Dried virus of tubercle has caused the disease by inhalation, in the experiments of MM. Gibboux, Tappeiner, Cadéac, and Malet; and M. Chauveau has similarly produced cow-pox and "clavelée," by insufflation of the powdered virus in the trachea. The bacilli of anthrax and of suppuration have caused infection by the same treatment.

Bang, examining twenty-one cases of cows affected with general tuberculosis, but with no signs of disease in the udder, found that the milk of only two showed virulent qualities upon inoculation in rabbits. He concludes that it is not necessary to consider all milk dangerous which comes from tuberculous cows, but that it should always be *suspected*, because no one can say when the udder will be diseased, and because, without this, the milk from tuberculous cows contains the virus in rare cases.

Galtier only found virulence in milk when the udder had become tuberculous. But since this is very difficult to recognize, "the milk should be considered dangerous which comes from any animal affected or suspected of being affected with tuberculosis." [1]

[1] State Board of Health, New Hampshire, U.S. Report, 1889. By Harold Ernst, M.D.

Hirschberger's results were as follows—Positive results were obtained in 80 per cent. of the cases of injection with milk from cows in a very advanced stage of the disease; in 66 per cent. of those from cows with a moderate degree of disease; and in 33 per cent. of those from cows in which the disease was localized in the lung. He found the bacilli in only one specimen of milk, and therefore regards inoculation as the more certain test as to the infectiousness of milk.

The experiments made under Mr. Ernst's supervision gave the following results with milk from cows more or less tuberculous, none of them having marked signs of disease of the udder—Out of 114 samples of milk, seventeen were found to contain the bacilli of tuberculosis. These seventeen came from ten different cows. The milk coming from cows with no definite lesion of the udder may contain the infectious principle of tuberculosis, if the disease be present in other portions of the body of the animal. The bacilli were found in the milk nine times after the cream had risen, and in the cream eight times. Inoculating rabbits with milk or cream from various cows, 10·2 per cent. became more or less tuberculous, and inoculating guinea-pigs, 28·57 became tuberculous. Out of fourteen cows, the milk was shown to be infectious in seven, or in 50 per cent., by inoculation experiments. Bacilli were found in milk or cream, and successful inoculation experiments made with the same specimen in five different cases. Of thirteen calves fed with milk from cows affected with tuberculosis, but not of the udder, five, or 41·66 per cent., became tuberculous. Pigs were infected in two out of five animals. The experiments, which were undertaken by the Massachusetts Society for the Promotion of Agriculture, showed—That there is no ground for the assertion that there must be a lesion of the udder before the milk can contain the infection of tuberculosis. That, on the contrary, the bacilli of tuberculosis are present and active in a very large proportion of cases in the milk of cows affected with tuberculosis, but with no discoverable lesion of the udder.

At the Congress on Tuberculosis in Paris (1891), M. Chauveau demonstrated the identity of human and bovine tuberculosis, and that infection could be caused by diseased food.[1] M. Vignal showed that human tuberculosis and that of birds is not identical. Similar results, but showing, nevertheless, indications of a unity of origin, were obtained by MM. Cadiot, Gilbert, and Roger.

The mortality from phthisis in London would appear to have diminished as follows in London during thirty-seven years[2]—

1851-60.	1861-70.	1871-80.	1881-87.
2·89	2·83	2·51	2·11

But it is possible and probable that in the earlier periods some other respiratory diseases were mixed up with true tubercular phthisis in the tables. Thus in dusty occupations, the inorganic irritant produces chiefly bronchitis, asthma, and fibroid pneumonia.

Koch has shown how enormous numbers of bacilli may be distributed in the air and on the ground from only one patient, and how infection is explained by their long survival in a moist or dry state.

[1] *Public Health*, September, 1891.

[2] *Ibid.* June, 1889. Dr. Henry Welch.

The most important morbid conditions favouring their development are diseases such as measles, pneumonia, etc., where there is denuded epithelium and secretion difficult to dislodge, and suitable as a nidus for the microbe. Abrasions of mucus membrane may allow entrance to the nearest glands.

The editors of the Report of the Results of the Inquiry by the Collective Investigation Committee of the British Medical Association, state that one fact seems to be established beyond question, and that is, that if phthisis is a communicable disease, it is only so under conditions of extremely close personal intimacy, such as persons sharing the same room, or shut up together in numbers in close, ill-ventilated apartments.

Fleming has stated[1] that tuberculosis is terribly common among cattle, especially in the choicest breeds; that it is increasing; and as early as 1874 he called attention to the dangers of meat and milk from such animals.

From Dr. Ogle's Supplement to the Forty-fifth Annual Report of the Registrar-General, on the comparative mortality of males of twenty-five to sixty-five years of age in certain dust-inhaling occupations, from phthisis and diseases of the respiratory organs, we gather that the classes least affected are coal-miners, joiners, and bakers, and those most heavily attacked are cutlers, file-makers, potters, and Cornish miners. The figures for phthisis are as follows—

Coal-miner	126
Carpenter, joiner	204
Baker, confectioner	212
Plumber, painter	246
Mason, builder, bricklayer	252

[1] Veterinary Congress, Brussels, 1883.

Wool manufacturer	257
Cotton manufacturer	272
Quarryman	308
Cutler	371
File-maker	433
Earthenware manufacturer	473
Cornish miner	690

The average of all males in England and Wales is 220, and of fishermen only 108. The proportion of males dying of *all* respiratory diseases in England and Wales is 340; the number of fishermen, 198; the number of miners, 328; the number of masons, etc., 453; the number of bakers, 398; the number of cutlers, 760; the number of potters, 1118; the number of Cornish tin, etc. miners,[1] 1148. The worst effect is evidently produced by the sharpest kind of dust, and the scouring and brushing of earthenware and china, performed by women, soon starts disease in the healthiest people.

The unhealthiest work of a dusty kind is that in which large quantities of fine, gritty, angular dust is given off, and in which the temperature is high, or the changes of temperature large. The coal-miner who works in a very dusty air is remarkably immune from phthisis; but we must remember that this air is free from the germs of disease which exist in abundance in the rooms where tailors, drapers, and needlewomen work, and which, with organic emanations, cause the high rate of mortality in these occupations. The miners' houses too are usually fairly well built, and not overcrowded.

[1] The mortality of Cornish miners was found to be three times that of the surrounding population, owing apparently to the high temperature of the mines and bad ventilation.

The immunity of fishermen illustrates the importance of pure air; and the small rate of mortality of this class from phthisis would be still further reduced if their houses were equal to the miners' in comfort and roominess.

In Blackburn it has been found that between the ages of fifteen and twenty-five, 11·4 per cent. of the weavers, 6·4 of the spinners, and 2·3 of the labourers die from phthisis and lung diseases.[1] Here we have some of the favouring conditions of consumption brought closely into view. The weaver has much worse ventilation, worse air, and less cubic space than the spinner. In the spinning- and card-rooms ·55 per cent., in the weaving-sheds ·7 to 1·4 per cent., of carbonic acid was found. No doubt the air was correspondingly vitiated by solid organic matter. Supply of fresh, warmed air, by driving it in over steam-pipes, or otherwise, is very important, much superior to the exhaust system; and one of the largest employers found that by driving in warmed air so as to comply with the Act, the production of the looms has been increased by 2·6 per cent. through the better working power of the operatives. The total mortality among weavers up to thirty-five years of age was 30 per cent. of deaths at all ages; among labourers only 13·8. This is a striking proof of the fatal evil of vitiated and rebreathed air. In 1889, Dr. Barwise noted that 20 per cent. of the deaths of 472 cotton operatives dying over ten years of age, took place between ten and twenty-five, while only 6·8 per cent. of 366 deaths of labourers occurred in that age period.

[1] Annual Report on Health of Blackburn, 1890. By Dr. Barwise, M.O.H.

At Portsmouth prison, it was found that in cells where the carbonic acid was not above ·7 per 1000, the convicts were robust and healthy; while the convicts living in cells which were badly ventilated, and yielded 1·0 per 1000, suffered from anæmia, lung and other diseases.

A very valuable inquiry was made by Dr. Niven, M.O.H. for Oldham, on the prevalence of consumption, and the conditions in which infection is operative.[1]

The main results of his inquiry may be shortly stated as follows—Healthy, robust people of good habits seem not to take consumption except under exposure to intense infection. In many cases infection seems to have been conveyed by means of food. In presence of a lesion a less degree of infection will give the disease. Thus people who have had accidental injuries, or weakening illness, should be specially shielded from infection due to tainted air, food, or houses. Exposure to known causes of infection was clearly made out in a large number of cases, the majority out of 102 cases. Infection was usually caught from close association with persons suffering from consumption. Out of seventy-five houses of which the condition was noted, thirty-five might be regarded as wholesome, thirty-four as unwholesome, six as fairly good. Damp, bad ventilation, dirt, and overcrowding were frequent, especially damp, and drains were often very offensive. Of twenty-six persons not exposed to traced causes of infection, and not engaged in unhealthy occupations, there were only seven who were not exposed to extremely unfavourable conditions, whether from personal habits, lesion, unhealthy dwellings, or a combination of these.

[1] *Public Health*, July 1891.

Out of ninety-seven cases, forty-four showed no history of heredity whatever, and twenty were connected with cases in the same family solely by links of infection —probable, presumable, or possible. Thus even predisposition through heredity is not shown to be strong, though undoubtedly inheritance of feeble health or weak chests has some effect in increasing the chances of contracting consumption. The cases investigated give a considerable body of facts indicating the direct infectiveness of consumption; the great value of preventive measures is demonstrated, the influence of bad houses in increasing the prevalence of the disease is clearly marked, and still more clear is the influence of weak physique and intemperate habits.

The health attained in British convict prisons is very remarkable. Out of a prison population with a daily average of 4807 in the year ending March 31, 1891, only nine died of phthisis. In the preceding year only seven had died of phthisis.[1] According to the report of the medical officer of Wormwood Scrubs Prison, destructive lung disease of the more chronic form, coming under the term of phthisical disease, has been of late years of very rare occurrence; and acute bronchitis, inflammation of the lungs, and rheumatic complaints are also rare.

The belief that phthisis is caused by damp soil and marshy ground is shared by Dr. Ransome, Dr. Bowditch of Massachusetts, Dr. Buchanan, and Dr. Haviland; and the Registrar-General of Scotland remarks that the towns or houses which were situated at or near undrained localities, or were on heavy soils, or on low-lying ground, and whose sites were consequently kept damp, had a

[1] Report of the Director of Convict Prisons, 1890-91.

very much larger number in proportion of cases of consumption than towns, villages, hamlets, or houses which were situated on dry or rocky ground, or on light, porous soils.[1] A similar distribution occurs with other diseases affecting the respiratory organs, such as measles, whooping-cough, and pneumonia.

Dr. Hanau, of Carnarvon Division, Upper Karoo Plateau, South Africa, reports the almost complete absence of pulmonary phthisis among persons born and bred in that area, and the very favourable effect of the climate on imported cases.[2] Extreme dryness, porous soil, great elevation, almost cloudless sky, out-door life, and absence of worry are adduced as contributing to this immunity. The nights are very cold; the summer days are very hot and dry.

Dr. Arthur Ransome[3] quotes Dr. Guy as having ascertained that of 104 compositors who worked in rooms of less than 500 cubic feet for each person, 12·5 per cent. had had symptoms; of 115 in rooms of from 500 to 600 cubic feet, 4·35 per cent. showed symptoms; and in 100 who worked in rooms of more than 600 cubic feet capacity only two were afflicted in the same way. This shows emphatically the importance of ventilation. Dr. Ransome[4] quotes a table drawn up by Mr. Baxendell showing the larger prevalence of consumption and respiratory diseases in crowded towns than in the country. The mortality for Westmoreland was 2·27, for North Wales 2·51, for all England and Wales 3·54, for Salford 5·12, for Manchester 6·10, for Manchester township 7·7.

[1] *Health Journal*, January 1885.
[2] *Health: the Voyage to South Africa, etc.*
[3] *Health Journal*, January 1885.
[4] *Sanitary Record*, January 6, 1877.

Sunlight is potent (Koch) for the gradual destruction of tubercle bacilli. Experiments made by Dr. Ransome and Dr. Dreschfeld tended to the conclusion that fresh air and light and a dry sandy soil have a distinct influence in diminishing their virulence. Savitzky found that the bacillus retained its virulence in ordinary room conditions about two and a half months, and in dark places about the same length of time. With regard to "disinfectants," some of the ethereal oils, some of the tar dyes, silver and gold compounds, especially cyanide of gold, strong carbolic acid acting for a long time, and above all, heat, are able to weaken or kill the bacillus outside the human body.

The probable manner in which the tissues and cells of the healthy body are able to wage successful war against invading bacilli is full of interest, and has an important bearing on the prevention of both this and other infective diseases.[1] The value of careful nutrition and of all measures against depressing influences, both as a preventive and as a check on tuberculosis, is proved beyond question.

Numerous experiments on young pigs, on calves, and on hens, have been recorded in which feeding with tuberculous milk gave tuberculosis. With milk obtained from cows with tubercular disease of the udder, Bang produced tuberculosis both by inoculation and by injection. The careful examination of cows supplying milk has been carried out to a very great extent by a Milk Supply Association in Denmark. Six special veterinary surgeons, in addition to local practitioners, are constantly employed in examining and making notes of every animal. The detection of the disease is un-

[1] Woodhead's *Bacteria and their Products*, p. 230.

fortunately no easy matter, and its progress is so rapid that frequent inspection is necessary. Tubercular disease of the intestine, etc., of which so many children die, is almost certainly caused by infected milk, and probably also many cases of tuberculosis in adults, so that these precautions are necessary in the public interest.

Hoffmann found the bacillus of tuberculosis in four flies which he examined in the room of a patient who died of the disease. Feeding flies with phthisical sputum gave a positive result, and portions of these flies inoculated into animals gave positive results in five out of nine cases. Spillmann and Haushalter recorded similar results.

M. Cornil has found tuberculous cultures strongly infective when introduced to the intestines of animals.[1] Half of the animals subjected by Veraguth to the inhalation of tuberculous sputum developed the disease. Many cases of inoculation of tubercle by the skin or wounds have been recorded.

Dr. Theodore Williams found the bacillus deposited on a glass smeared with glycerine exposed for five days in a ventilating shaft at Brompton Hospital. None were found in the shaft of a ward containing non-phthisical patients.[2]

Von Wesener and others found that rabbits fed on tuberculous sputum, fresh, dry, or treated with digestive fluids, always developed tuberculosis. Similarly, Bollinger observed tuberculosis of the intestine, liver, and spleen, in three fowls which had fed on tuberculous sputa in the court of an hospital.

[1] *Public Health*, Sept. 1888.

[2] *Ibid.*, Oct. 1888.

Bang found the milk in cases of tubercle of the udder always to contain the specific bacillus, and it constantly produced tuberculosis.[1] The milk of tuberculous cows of which the udders were not affected also sometimes contained the bacilli, and this milk could then produce tuberculosis. Galtier found that whey and cheese from such cows infected. The researches of Villemin, Toussaint, and Koch, first distinctly showed the parasitic nature of tuberculosis. The bacillus has been found in the sputum and in the excrements of tubercular subjects, and these should therefore be subject to regular disinfection. It does not multiply in distilled water, but does so largely in beef solutions. Arsenic, boric acid, and mercuric chloride do not interfere with its development, but rather promote it. It is not killed by various acids. Salicylic acid however destroys it.[2] "The breath of a phthisical patient is capable of giving rise to growths of the bacillus on sterilized blood serum." The saliva and sweat of persons in advanced phthisis contain the bacillus. The bacillus enters the body in the following ways—By inhalation, by swallowing, by means of a wound, scratch, or sore, by heredity. Milk at all open to suspicion should be boiled; sedentary, inactive life avoided; infection specially guarded against; ventilation provided for; and all infected articles disinfected or destroyed. "The envelopes moistened by phthisical patients are capable of giving rise to growths of bacillus tuberculosis in sterilized blood serum." "The clothes of a girl who had contracted phthisis while at school, and died of that disease, passed to her sister, who died of the same disease. A third sister died under like conditions."

[1] *Public Health*, Nov. 1888. [2] Griffiths' *Micro-organisms*.

It has been found in Prussia that persons nursing the sick were affected by tuberculosis in varying proportion, partly dependent on the manner in which the sputum was treated.[1] Cloisters with a small population, and those which took charge of surgical cases, had a small mortality.

Consumption and the whole class of tubercular diseases to which it belongs have been proved to be infectious.[2] Toussaint found a large number of cattle sent for slaughter to be affected. Pigs fed with the lungs of such animals caught it. He found the virus pervading the nasal mucus and saliva. Thus they caught the disease by feeding at a common trough. No contagious malady is more virulent among animals. The juices of the muscles are also infected by the organism. Toussaint isolated this microbe of tuberculosis and produced the disease through cultivation in soup. It was also reproduced from an underdone steak.

Dr. Crisp stated that he had examined nearly all the animals of the Zoological Gardens, London, which had died, and he found that all vertebrates were liable to tubercle.[3] Wild animals are *seldom if ever* affected by it.

Dry places are much less productive of cases of phthisis than damp places on wet soils. Of twenty-two cases at Bowdon, in ten years, 1875-84, eleven occurred on low-lying clay land, and nine had contracted the disease before arriving in the district. Of the remaining two, one had to be every day in

[1] *Public Health*, July 1888.

[2] Address on Health by Dr. Cameron, M.D., M.P., Dublin, 1881. *Social Science Association Trans.*, 1881.

[3] *International Medical Congress*, 1881, p. 307.

Manchester, and the other was a City Missionary, also much in town.[1]

The effect of sanitary works on phthisis is important and remarkable. At Bombay, the reduction of the death-rate from phthisis after sanitary works was 41 per cent., at Cardiff 17, at Croydon 17, at Dover 20, at Ely 47, at Leicester 32, at Macclesfield 31, at Merthyr 11, at Newport 32, at Rugby 43, at Salisbury 42, and at Warwick 19.[2]

The bacillus tuberculosis of consumption can be cultivated artificially, and when inoculated gives consumption. It is very difficult to kill, and cooking and digestion hardly destroy it. It may be fatal if simply inhaled. Many so-called hereditary cases are cases of infection from parents. The death-rate from consumption in Bradford for 1875-79 was 24·75, and for 1879-84 it was 20·7.[3] Dr. Hime has given in his *Retrospect* some useful rules and precautions against consumption.

The death-rate from phthisis in England per million was, from 1861-70, 2488, and from 1881-83, 1846, representing a total *annual* saving of 16,692, probably largely due to sanitation.[4]

The mortality from phthisis per million has diminished in every decade since 1851, as represented by the following figures [5]—

1851-60	2679
1861-70	2475
1871-80	2116

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[1] *Trans. Sanit. Inst.*, 1885-6, p. 85.

[2] *Vital Statistics.* Newsholme.

[3] Report of the Health of Bradford for 1884, with Retrospect of ten years, by Dr. Hime, M.O.H.

[4] *Trans. Sanit. Inst.*, 1885-6.

[5] *Progress of Preventive Medicine.* Thorne Thorne.

In 1888 the rate per million had been still further reduced to 1541 per million.

It would seem therefore that the progress of sanitation, or of the general welfare of the people, had contributed to the diminution of this disease. The number of lives thus saved in England and Wales amounts to no less than 29,000, of persons who would otherwise have succumbed to consumption.

Dr. Arthur Ransome has dealt with the causes and means of prevention of consumption in a very complete manner,[1] and from his thorough examination of the distribution and incidence of the disease in England and over the surface of the globe, we are enabled to come to very definite conclusions with regard to its growth and preventability.

It is clearly not a disease of any particular climate or situation, for it occurs in nearly all parts of the world. The mortality is great in all the chief cities, varying from 208 per 1000 deaths at Vienna, to 121 in London, 115 in Lisbon, and 114 in Rome. There are, however, great variations in its prevalence within small areas; thus at Edinburgh the rate per 1000 deaths is 102, in Glasgow 371, in New Scotland (Canada) 241, in Quebec 138, in Archangel 190, in Riga 30, in Dresden 147, in Weimar 74. In Ireland the mortality per 100,000 in ten years was, in the eastern division 259·62, in the western 95·64. In Egypt the general rate is 25, in Cairo 101 per 1000 deaths. In the towns on the west coast of Scotland it is very common, in the Hebrides almost unknown. The places most free from the disease are the following—Greenland, Labrador,

[1] *The Causes and Prevention of Phthisis.* By Arthur Ransome, M.D., F.R.S., 1890.

Iceland, Spitzbergen, Nova Zembla, Finland, Siberia, and the northern parts of North America; but especially deserts and sparsely-populated districts, mountain ranges and high plateaux. The Arctic regions are by no means exempt from consumption, and it occurs often in the crowded huts of the Esquimaux.

Without further discussing negative evidence, it may be stated that an examination of all the circumstances leads distinctly to the conclusion that consumption is a disease of overcrowding, and of infection taking effect in ill-ventilated houses.

The following interesting facts, among many others, tend to prove the truth of this great discovery. The deaths from consumption in the army and navy have enormously diminished concurrently with improvements in hygiene, and especially in ventilation. The death-rates among artisans and workpeople employed in close rooms is greater than that of persons employed in well-ventilated workshops, and those persons who are employed out-of-doors are affected least of all. Blacksmiths, charcoal-burners, forgemen, iron-puddlers, and sailors and coachmen, are peculiarly free from it. Soldiers on campaign, fishermen, hunters, gipsies, engine-drivers, gardeners, and agricultural labourers are largely exempt. In agricultural districts, the women, who live much more indoors than the men, suffer at double the rate. In manufacturing districts, that sex which is most employed in heated, close factories or workshops is most affected. In Canada, the mortality among the troops from 1830 to 1837 was 23 per 1000; after defects in the barracks had been set right and better ventilation introduced, the rate fell to 9·49 between 1863 and 1872; and to 6·0 in 1874. The Bedouins on the coast of the

Red Sea who exchange their tents for stone-built houses suffer from consumption. In Algeria, the nomad Arabs are free, but among the captives many die of it. In the fine climate of Alexandria the mortality is nearly double that of England, but in the Soudan and interior of Africa it is as yet almost unknown. While the western prairies of North America were sparsely inhabited the disease was very rare, but with increased immigration it is developing. It is a well-known fact among volunteers and others who camp out, that the outdoor life, provided the tents are dry and their ventilation good, keeps them remarkably free from colds and illness, and consumption seems to depend largely on the same conditions; close, stagnant, rebreathed air, and damp, breath-condensing walls favour its development, while free ventilation and outdoor life almost forbid its appearance.

Dr. Greenhow concluded, from his inquiry in 1860, that "in proportion as the male and female populations are severally attracted to indoor branches of industry, in such proportion, other things being equal, are their respective death-rates by lung-disease increased."

Sir John Simon says—"Among the aggravating circumstances that may indefinitely increase this evil (lung-disease), probably none is so effective as the bad ventilation of the work-place."

Dr. Farr showed that the mortality from disease of the respiratory organs and phthisis is in relation to the density of the population. He attributed phthisis to the inhalation of expectorated tubercular matter, dried and floating in the close air.

Dr. McCormac insisted that "wherever there is foul air, unrenewed air, impure air, there we meet with consumption, there we meet with scrofula, and an untimely death."

Dr. Ransome found that in Manchester and Salford the districts most affected were close courts and alleys, the shut-in and blocked-up lanes, and above all the houses built back to back with no through ventilation. The number of cases recurring in the same houses was disproportionally great, and this fact has been observed by others. According to Dr. Flick of Philadelphia, a house which has had one case of consumption will probably have another within a few years, and may have a very large number of cases in close succession. The neighbouring houses are considerably exposed to contagion.

The walls of houses have been shown by Cornet to contain the virus (microbe) in an active condition.

The tuberculosis of domestic amimals appears to be a disease of overcrowding, for it does not occur in wild animals.

The bacillus of consumption was discovered by Koch. Tubercular bacilli were found by him in dried and powdered sputum. They are still virulent in the dried sputum after a lapse of several months, so that their vitality enables them to infect places for a long time after the consumptive patient has left the room, steamboat, car, or place of amusement. Bollinger has calculated that one phthisical person may eject from his body in the course of twenty-four hours no fewer than 20,000,000 of bacilli. It is probable that most persons can breathe in a good many of these bacilli without becoming infected by them; but in unfavourable conditions, that is, in a foul, damp, and heated air, they are likely to take effect on a certain proportion of people exposed to them. The bacillus only requires a certain amount of moisture, a temperature between 82° and 107° F., and a supply of nitrogenous food, in order to grow and multiply, and these it finds in the human body.

From some very interesting experiments made by Bollinger and others, we learn that the healthy human body is probably able to render innocuous or destroy a moderate number of the bacilli inhaled, but when the number of invading bacilli is great, the resistance of the body and blood is less likely to be successful. Probably there are very great differences in susceptibility between different persons, as in other infectious diseases. When injected into the peritoneum, however, it appears that a very small number of bacilli will infect.

Consumption is rarely if ever inherited, but the disposition which admits of the easy reception of the poison is certainly often inherited.

It is well known that certain disorders, such as enteric fever, measles, small-pox, etc., often leave behind them a tendency to tubercular disease. Inflammatory diseases of the lungs, such as pleurisy, acute bronchitis, broncho-pneumonia, and croupous pneumonia, also prepare the way for phthisis, probably owing chiefly to the lesions of surface which allow the entrance of the tubercle bacilli, and also to the weakening influence of these diseases. Dr. Ransome notes that the detachment of the ciliated epithelium in, *e.g.*, acute bronchitis, would allow the bacilli to find a lodgment and to remain, owing to the deficiency of the expulsive machinery. In catarrhal pneumonia, etc., "the lung loses its elasticity, its tissues are more open to infection, the residual air becomes stagnant, and its impurities, including foreign germs, are liable to be imprisoned for an indefinite time." The action of dust, such as that to which grinders, flintworkers, brushmakers, etc., are exposed, and the smoke of large towns, would in some respects be similar in undermining the resistance of the lungs to the attack of tubercular bacilli.

Infection usually occurs in one of the following modes—(1) By the food. Animals fed experimentally with the raw flesh of tuberculous cattle were attacked with tuberculosis.[1] But since animal flesh used for human food is more or less cooked, this is probably not a very common means of infection. Certainly, a large quantity of badly-cooked tuberculous flesh is eaten, and such food cannot be free from danger; but since races which do not eat any animal flesh are also subject to consumption, the prevalence of the disease in Europe probably depends more on other sources of bacillar poisoning. The evidence as to the part played by milk is much more serious. According to Hirschberger, 25 per cent. of all children dying under one year of age die of tuberculosis; the result, it may be assumed, of intestinal affection. Bacilli are found in milk, both when the udders of tuberculous cows are affected and when they are not; and feeding animals with this milk gives tuberculosis in a very large proportion of cases. A large number of observers regard as dangerous the use of milk from tuberculous cows, and it is doubtful whether milk should ever be used unboiled.

(2) By the tainted air in infected places. The conditions favourable to the bacillus, and to its transference to fresh human subjects, are a warm climate,

[1] Von Wesener. Toussaint. Villemin. Cornil.

damp soil and dwelling-houses, air befouled with organic vapours, and surrounding walls, floors, etc. contaminated with organic dirt, largely due probably to emanations from the lungs and skin. Close, confined air, and infected surrounding surfaces, are the most potent carriers of the virus.

With animals the same cause is predominant. Crowded byres, unventilated and unclean stalls, produce a vast amount of disease in our domestic animals. In Alsace, a farmer lost a cow every year for six years in succession, always in the same stall in his cow-shed. Then all the woodwork was removed, the manger and rack thoroughly disinfected, and the place rebuilt. It was then reoccupied by several animals in succession, and none contracted tuberculosis. This very instructive example shows the persistence of the infectious matter on outside objects, independently of the presence of a tuberculous animal, and the capacity of growth, or at least retention of vitality, possessed by the bacillus on favourable soil outside the body. Similar observations are not wanting with regard to the occupation of infected dwellings by healthy persons, who soon after their entry have become subjects of consumption. The great benefit frequently derived by consumptive persons from change of residence, is probably largely owing to their removal from the action of the bacilli, with which, in infected places, they are surrounded. According to Dr. Ransome, wherever a dry, pure soil, and germ-pure air exist, that is the best health-resort in which the largest amount of outdoor occupation can be secured, together with the greatest amount of bodily comfort. If outdoor air, dry clean habitations, and absence of irritating or organic dust are good for consumptive invalids, they are equally important for the prevention of the development of this disease. Professor Carnelley has found by experiment that clean houses, with ventilation, have in their air only a small fraction of the number of the bacilli contained in the air of dirty houses; and, moreover, that in badly-ventilated schools micro-organisms increase up to a certain point with increase of wall and floor space. The floors of schools and houses appear to be active in the production of organisms, and they are little affected by scrubbing, except on the day after; the interstices between the planks may perhaps contain large numbers, which are kept alive by the dampness of the wood. New schools are much less contaminated by microbes, and the process of infection of walls and floor appears to be a very gradual one. These experiments point to the possibility that many tubercular bacilli lurk in the floors and walls of old houses. Clearly it would be a measure of safety to use only such materials as could be easily and frequently cleaned.

It is only in crowded, ill-ventilated rooms that the bacillus of tuberculosis usually appears capable of exercising much power over unaffected persons. Impurity of air, rebreathed air, is a very important factor in the production of consumption, as it is for the transmission of other infectious diseases. Cattle are crowded in dirty, ill-ventilated sheds, with the result that a very large number of milch-cows are smitten with tuberculosis. The milk of these cows reproduces consumption in mankind. Among mankind, again, crowding and dirt produce consumption to an enormous extent. It is not only in houses, however, that infection may be caught. Crowded assemblies, and crowded, close railway carriages which, when full, have been proved to contain exceedingly large numbers of microbes, may start the disease in many persons who are not very susceptible. The susceptible, and all who have been recently reduced by disease, should certainly avoid these places. A draught is often less dangerous than a close room or unventilated compartment. On the whole, it may be concluded that if the hygienic conditions prescribed to consumptives were made general in the community, *i.e.* pure air, clean rooms, good food, untainted water and milk, the disease would be very much less common than it now is, and there would be reasonable hope of reducing it to a very low degree of prevalence within a few generations.

Although in crowded and dirty quarters consumption is distinctly infectious, the rarity of infection in well-ventilated rooms where precautions are taken is so great, that even in hospitals for consumptive persons, cases of transmission seldom occur.

The chief means of prevention of consumption will be improvement in dwelling-houses, allowing better circulation of air and easier cleaning, dry and clean surroundings and basement; the demolition of pestiferous dens, close courts, alleys, back-to-back houses, and damp cottages; paving ground-floors with impervious material and admitting free ventilation underneath; construction of walls and floors with a smooth surface, not admitting the collection of dust in interstices; increase of space (cubic feet of air) in proportion to the number of persons in towns and houses; good homes or hospitals for consumptive persons; careful disinfection and disposal of sputum and other discharges; disinfection of rooms which have been occupied by the consumptive; better regulations for the prevention of tuberculosis in milk-cows and cattle; precautions against the sale of milk from cows affected with the disease; the boiling of all milk of which the source is not known to be free from suspicion, and other measures.

Dr. Ransome proposes another advance of very great importance in the interests of public health, namely, that phthisis should be classed with other infective disorders, and notified to medical officers. The local authority would then see to the hygienic condition of the dwelling where the case occurred, and to the comfort, and, if desired, the removal, of the patient. "There are probably few exanthematous diseases that could be so easily and effectively controlled."

Dr. Coats, of Glasgow, a high authority on this subject, is of opinion that the presence in the general community of consumptive persons, from whom large quantities of tubercular bacilli are continually given out, supplies one of the necessary elements in the propagation of all tubercular disease. He considers that treatment in well-managed sanatoriums would result in a much larger number of cures than can be looked for under present circumstances, besides reducing the diffusion of the disease from the sick to the healthy. Propositions for the reduction of consumption derive great encouragement from the extinction of leprosy in this and in other countries. Leprosy, according to Dr. Ransome, resembles tubercle, both in the form and behaviour of the bacillus, and in the mode of attack. The entrance of the virus takes place at the most exposed portions of the body. In phthisis the atmosphere conveys the bacillus to the air-passages, and in scrophulous glands to the nearest sore; in leprosy contagion takes place first on exposed parts—the bare hands and face—and in countries where the feet are uncovered these are the first to receive injury. Some previous injury is necessary; the epidermal covering is impenetrable by the parasite. The pathology of the two diseases is also strikingly similar. Moreover, both have been widely spread over the world, and exist endemically where population is somewhat thickly gathered.

Dr. Erasmus Wilson attributes leprosy, in its origin, to miasma from marshy soil, and has given instances of cases arising from this cause. The decrease of leprosy in Europe may be owing partly to the drainage and cultivation of the soil and the better conditions of living, but also, in no small degree, to the segregation of lepers in special hospitals, which were scattered over the country in the Middle Ages. Leprosy is no longer known in England except among a few persons who have become infected in foreign countries.

There is also plenty of evidence that consumption is in a large number of cases curable, and that many persons have been the unconscious subjects of consumption which has healed, so that the number of persons who are effected by tuberculosis is much larger than has been generally supposed.[1] "The number of susceptible persons in the general population may be counted by hundreds of thousands. The total annual death-rate by all other preventable epidemic diseases is about 45,000, that by tubercular maladies over 70,000. The chief object of measures of prevention should be to cut off the supply of the bacillus from

[1] International Congress of Hygiene, 1891. "On the need of Special Measures for the Prevention of Consumption." By Dr. Arthur Ransome.

without, especially (1) by the ingestion of tuberculous milk or flesh meat, (2) by the inhalation of tuberculous dust. The first of these requirements may be fulfilled by the more thorough and scientific inspection of meat-markets and dairy-farms, and by greater solidarity between urban and rural sanitary authorities. The second needs a thorough knowledge of the chief sources of infection by tubercle." It has been proved that the spread of the disease is greatly promoted by residence in damp, ill-ventilated, and filthy dwellings. Evidence has been adduced by Dr. Irwin of Oldham, Dr. Flick of Philadelphia, and by Dr. Ransome, of the existence in towns of tuberculous areas and infected houses. The duty of sanitary authorities is therefore to treat consumption as a disease analogous to leprosy, cholera, and enteric fever, in that it is a disease scarcely, if at all, directly contagious, but spreading by means of material thrown off from the bodies of patients. It should be combated by the time-honoured methods of (1) notification of cases, (2) disinfection, (3) hospital accommodation, and (4) general sanitary measures, such as ventilation, drainage, and reconstruction of unhealthy areas. Disinfection of sputum and other excreta could then be insisted upon. Hospital accommodation could be provided for those who were without proper lodging or accommodation, and measures of sanitary reform would not only protect persons from the danger of infection, but would render their bodies more fit to repel the attacks of this and other diseases.

A strong Health Department, consisting of eminent medical men and sanitarians, if given sufficient power, could certainly reduce consumption and other diseases very largely within a few years, but certain changes are necessary in our views of the responsibility of house-owners, builders, and traders before the path of such a body would be clear before them. We condemn the grocer who sells adulterated coffee, but the milk-dealer is allowed to sell the milk of tuberculous or otherwise diseased cows with impunity, the consequences to consumers being far more serious. We condemn false weights and measures, but we allow parsimonious builders and small house-owners to let as "dwelling-houses," dens which would be more honestly described as death-traps. No house should be allowed to be occupied which is not reasonably well drained, ventilated, and protected from damp and ground exhalations, and provided with water either by public supply or by rain-water properly stored. Workshops and factories also require more careful regulation, especially with regard to ventilation. Overcrowding should be prohibited more stringently than at present. The zone system of railway fares would greatly aid any efforts to reduce density of population.

Light, air, space, exercise, and cleanliness should be made easy of attainment and common to every human being, and in the provision of these benefits the claims of animals, which are so closely dependent upon us, should not be forgotten.

Colds. The following notes might appear trivial if in relation merely to a minor malady, but we know on the best authority that besides being troublesome inflictions in themselves to many people, colds often prepare the way for diseases of a much graver character. Consumption, according to physicians of great distinction, has almost always been preceded in its victims by an ordinary cold, and therefore this slight ailment, like the "little fire which kindleth a great matter," cannot be left out of account.

The most common cause of colds is said to be a draught. What is a draught? Not the steady breeze in the open air of the country, or a light shifty movement of the air on a warm summer morning, or a strong gale at any season of the year. A draught I take to be a strong or gentle movement of the air where to some degree confined, deflected, or under cover. But not all draughts are apt to give colds. Draughts might perhaps be arranged in some sort of order, according to their capacity of giving colds. The gentle down current from an ordinary large window or skylight is remarkably capable in this respect. It is caused by contact with the cold glass, and descends owing to the increased specific gravity of the cooled air, until by the sill the current from a large window is at once perceptible. In this case we have air which is impure (the air of a room in use contains thousands of dust-particles in every cubic inch, and some living organisms) suddenly cooled, and descending imperfectly mixed with the warmer air of the room, bearing with it dust on which some deposition of moisture as a consequence of cooling must have taken place. The cool current on the head drives the blood instantaneously from the skin to the inner surface of the throat, mouth, and nostrils.[1] This rush of blood inwards, and the irritation of dust-particles and cooler air on the mucous membrane thus excited, may cause the first feeling of a cold in a susceptible subject. But a third factor is probably needed to develop a true cold.

[1] See Mr. Garrod's experiments, noticed on p. 377.

Other situations may be mentioned as apt to produce a cold. Between an open door and window, on the platform of a covered railway-station, under an archway, at a street corner, near a chink in a door or window, in any current of air at a crowded meeting, in a slight draught in a crowded railway-carriage, in a passage where warm and cold currents mix, in a room where the fire is going out, in the open air on a still evening or when there is mist or fog, in shady damp woods on a fine evening after rain, sitting long with wet feet—all these conditions are conducive to the production of a cold.

In the following conditions colds are not often caught:—In the open country under the open sky, in breezy open places, by the seaside when the wind is from the sea, in sailing on the open sea even in cold weather, on hill-tops, in riding or driving, in a clean and empty railway-carriage with a thorough draught at a distance from towns, in high airy localities, in the upper stories of houses, on cloudy mild evenings, in isolated places remote from towns, in woods during dry weather.

Very severe colds, and sore throats with fever, are caught in the neighbourhood of marshes and estuaries occasionally covered by sea-water or slightly saline, also in marshy, damp ground generally, and on the banks of rivers on summer or autumn evenings. The neighbourhood of Southampton Water, when the tide is out, and in general, places where fog or mist forms quickly on summer evenings, and where there is little circulation of air owing to the formation of a river or basin of cold air; lakes, rivers, or marshes, of which the banks are marshy, sodden, or clayey; and rich irrigated meadows—all these are situations productive of colds. In Italy, the sunset hour in low situations, on river-banks, and in malarious places, gives rise to a severe cold commonly termed "a fever."

But there are other circumstances of a different nature which very commonly seem equally effective. None is more potent than proximity in a small confined space to persons actually in the midst of an attack. People who arrive in town after spending some months in the country are very liable to catch cold. It is said with regard to horses, that 95 per cent. of the horses arriving from the country are taken ill. Crowded rooms, omnibuses, and especially railway-carriages when the windows are closed are prolific in the causation of colds. The experiments of Percy Frankland have shown that microbes abound in quite unusual density in crowded railway-compartments.

Acid fruit, such as sour grapes, greatly favour the development of colds. Also irritating, icy, or scalding food or drink, especially in a town atmosphere. The fact that a wrap of some warm material round the throat often prevents a cold being caught shows the need of preventing congestion on the inner surfaces, and it appears that the acidity or alkalinity of the surface of the mucous membrane is almost equally decisive. The efficacy of ammonia taken within an hour or two of the first sensations of a cold might be experimentally compared with its influence on artificial cultivations of various microbes of a suspected class. The part which these play is not even yet known to be an important one, and their life-history does not appear to have been much investigated. According to Hajek, in acute catarrh the first stage of hyperaemia changes the mucous membrane and its secretion from the normal to the pathogenic condition. At the commencement of catarrh one kind of bacterium is either alone present, or much predominates. This is a diplococcus, growing, when cultivated on plates, in glassy colonies of a white colour. "As the coryza progresses, other bacteria make their appearance and complicate matters." In five cases Hajek has found Friedländer's pneumonic bacillus. The effect of an antidote, such as ammonia or eucalyptus, taken early, is an easily tested application of the principle of early attack on threatening zymotic maladies, a principle which holds to a great extent for individuals and communities. Pasteur is able, even some days after infection by rabies, to prevent the development of the virus within the body, and if vaccination thorough and extensive will save a population threatened by small-pox, there appears *à fortiori* to be reason to expect that prophylactic substances will be discovered which will be able to assist the human system in repelling successfully the first onset of many other zymotic pests, both great and small. Numerous experiments on animals have shown the effect of small infusions of antidotal matter in conferring immunity. The manner in which colds are spread in a family or household is very similar to what occurs in the propagation of influenza, but the infectiveness is less powerful in most cases. One member having caught cold, usually in a populous or crowded place, the next case usually occurs in another who has been most in his company, and in this way all the susceptible inmates are in a short time affected. The incubation period is usually from twelve hours to three days. The middle and later stages, when the cold is "in the head," appear to be the most infective. Among people who mix much with others in ordinary intercourse, susceptibility is less than among others who live chiefly apart or in the country, but they are often exposed to strong virus, and are therefore more frequently attacked. The highest degree of susceptibility is reached in people who, like the inhabitants of St. Kilda and of other small islands, are well isolated for a year or more. These people are almost all attacked with bad colds resembling a mild attack of influenza when a party arrives from the larger islands or from the mainland.

Immunity seems to be conferred by a severe cold against a second attack within a short period, but the protection does not remain with most people beyond a few weeks, unless perhaps for exposure to very dilute infection. Relapses are of course common if the subject be exposed to the weather, etc. before the cold is completely gone, but this is a feature in common with many zymotic diseases.

Colds, especially if neglected, are apt to give occasion for the development of other maladies; for instance, consumption, pneumonia, and bronchitis. The two former are in all probability caused by their particular microbe falling on congested, torn, or morbid surfaces in the throat or lungs, and to a condition of the system ill adapted to resistance; therefore all kinds of infection, dust, dirt, and crowded places are particularly productive of mischief in such a state.

From the above particulars it may be surmised that the cause of cold is either—1. A micro-organism in the general air. 2. A micro-organism usually present in the mouth, air-passages, etc., and only able to infect in certain conditions. 3. A micro-organism present in the air and in solid and liquid matter in certain situations.

The first supposition is excluded by the immunity usually enjoyed at sea, on mountains, on chalk downs, in dry countries remote from habitations, and on small islands. The second is excluded by similar considerations, and by the definite infection on exposure to cases, or to certain kinds of impurities in the air.

The third supposition appears to be wholly conformable to facts. An exterior chill or internal congestion may be taken as the preceding condition to most cases, except where a cold is caught by strong personal infection. And since persons confined to bed do not easily catch cold from another, some cause of congestion, however slight, is presumable in the majority of cases. Now the organism which is specially concerned in the production of colds takes advantage of this favourable excess of blood in the interior capillaries, and settles upon the inner surface of the air-passages or throat. Wherever the chill is severe, a small number of the organisms in the air may be sufficient to infect. Wherever the chill is slight, a large number may be required. Thus in the ordinary outer air of the country, colds are not easily caught, but in marshy places, towns, damp rooms, and crowded places a much slighter exterior chill determines an attack. From morasses and alluvial flats in most parts of the world the germs may be given off in large numbers, and may survive for some little time in the free air. The low ground near rivers, sodden flat land and pasture, and probably all places in this climate where decaying vegetable matter exists, are the chief sources of supply; but probably the majority of colds existing at any time are the result of personal infection. The occasional conveyance by clothing, etc., to isolated situations, and the fact that colds are occasionally caught in the open air at a distance from cities, valleys, and marshes, seem to show that the microbe is a very common and abundant product of the earth, and capable of withstanding atmospheric influences for a short time. Damp, and especially fog and mist, are favourable to its virulence as a constituent of the air, probably by preventing its death by desiccation and oxidation, the known fate of so many organisms. The worse character of colds caught over marshes, even without any obvious chill, seems to imply the origin of the microbe in such places. Given off into the air in multitudes and favoured by the condensation upon them of the mists of evening, which fall into horizontal layers by radiation and cooling, they would be specially virulent and dense. The habitat of the microbe seems to correspond very much with that of the malaria microbe in warmer climates, but it appears to be more widely distributed, and perhaps capable of travelling further in an active condition.

There is no lack of organisms in the air to account for the prevalence of colds, and it is interesting to note how exactly the distribution of microbes corresponds with what might be expected if some species is concerned in the production of colds.[1] The probability appears to be that it is allied to one of the mould-fungi, for these are both uncommonly light and widely distributed. Experiments have shown that microbes are much more abundant in inhabited than in uninhabited places, near low ground, marshes, and in valleys than

[1] See pp. 409 *et seq.*, and p. 440.

on high ground and mountains, and during a land-breeze than during a breeze from the open sea. The same words might be used as regards colds. Chilliness on board ship at sea is seldom pernicious.

The diminution of colds may be brought about by drainage of wet ground; by care for the dryness of foundations and for ventilation of houses; by avoidance of marshy, confined, damp situations; by all methods of increasing the dryness and purity of the air; by improving the sanitary condition and warming of dwellings, workshops, and dusty places; by increasing outdoor and diminishing indoor life; by proper clothing; by a better supply of outer air, which is at present extremely deficient, in meeting-places, schools, railway-carriages, etc.; and, wherever practicable and desirable, the isolation of any member of a household first attacked at least for a few days. This is above all needful in the case of tradesmen dealing in bread, milk, and provisions.

DENGUE.

Dengue is an infectious fever which occurs epidemically and sporadically in India, Burmah, Persia, Egypt, and other parts of Africa, North and South America, and the West Indies. It has not visited Britain. Epidemics occur at rather long intervals.

The period of incubation seems to be from five to six days. An attack of dengue does not give absolute protection against a second attack, though it certainly renders the patient less liable, probably for a moderate period.

The original habitat and sources of dengue do not appear to be known ; it may possibly arise from extensive marshes or infected soil in Asia, and the microbe may possibly be conveyed a considerable distance through the air without destruction. No doubt the ordinary means of spreading is by personal infection. Obviously a very few centres are capable of rapidly spreading such a disease (which is probably infectious before prostration, like influenza) over a large part of the globe. The marshes of Asia, exposed to the heat of the sun and drying winds, are so extensive that it might be supposed unnecessary that more than one spore in many millions should survive in order that a few susceptible persons in tropical countries should be affected, and from these the propagation would be by ordinary infection. Still, it appears very much more probable that these microbes are only developed on a great scale in certain favourable seasons, and that only the population within a moderate distance of their breeding-ground are directly attacked, the extension over the globe depending on ordinary infection and the recrudescence of the disease in favourable seasons and circumstances from seeds left by previous visitations. Clearly the periodical outbreaks of widespread epidemics of dengue would depend largely on the growth of a population not protected by previous attacks, as well as on favourable circumstances of season and communication. Decaying matter or filth may afford a nidus.

Isolation and sanitary measures generally, especially ventilation, would be most effective where an outbreak is probable, and wherever cases occur isolation and disinfection would prevent extensive prevalence.

DIARRHŒA.

The predisposing causes of diarrhœa, in addition to individual peculiarity, are childhood, especially the period of first dentition and weakness of the digestive organs. The exciting causes are, food in excess, or of improper quality, as salted meat; shell-fish; sour, unripe, diseased, or imperfectly masticated fruit or vegetables; impure water; entozoa, etc.; damp, cold, dark, unventilated dwellings; foul emanations from decaying organic matter; chills, etc.[1]

Diarrhœa is of course only a symptom of a disturbance which may be due to a variety of causes. The specific disease, epidemic or summer diarrhœa, is the only form here to be considered.

In many cases, perhaps the majority, diarrhœa is excited by the poison elaborated by a microbe which subsists on putrid food, foul water, or milk which has been exposed to emanations from filth or impure air. In others, the microbe may be capable of further existence and of elaboration of poison in the human body. Certain kinds of soil seem to evolve the microbes in large quantities in hot weather, and the organism may then be as abundant as that which in summer causes milk to turn sour. Probably rich soil, garden earth,

[1] Quain's Dictionary. Article "Diarrhœa," by George Oliver.

and any soil containing much organic matter or filth, would be above the average in the development of these microbes.

Diarrhœa is very frequently caused by the absorption of poisonous gases, and also, probably, of poison-producing microbes, through inhalation. Thus, the removal of the contents of a cesspool, or drainage work, or escape of sewer air into a house, is a common cause.

In India, according to Surgeon-Major Hendley,[1] many cases of diarrhœa at fairs, etc., seem to be caused by the habit of travellers taking supplies of food, perhaps serving for as much as a fortnight, in filthy cloths or turbans, worn in the heat on their filthy bodies.

Choleraic diarrhœa is often caused by tainted fish, and a large amount of serious cases among children in India and England is derived from the consumption of tainted cow's milk. Mere boiling or heating will not destroy the poison or the danger, though it may kill the microbe.

The infection of milk constitutes one of the most frequent factors in the causation of infant mortality.[2] A large proportion of the deaths of infants is due to diarrhœa. It is most prevalent among children artificially fed, and may be caused by a large number of different micro-organisms. Use of sterilized milk is somewhat disappointing, probably for the following reasons—1. The process is difficult. 2. When efficient the chemical poison (produced by microbes) is not destroyed. 3. The food may be reinfected in the alimentary canal.

Professor Brown said that the ordinary surroundings

[1] International Congress of Hygiene, 1891. [2] *Ibid.*

of the dairy in typical dairy districts were most filthy, and the emanations from such dairies were noisome; the collection of dairy products in such conditions was disgraceful.

Professor Fleming said that the conditions in which dairies are kept and cheese made were often most unfavourable. The slaughter-houses, also, in many towns were filthy in the extreme, the localities in which they were situated most foul.

Temperature is a very important element in the production and increase of diarrhœa.[1] When the mean temperature of a week reaches 55°, the deaths from diarrhœa begin to rise, but the rise is not equal for each degree above 55°. A rise from 55° to 60° has a less effect than a rise from 60° to 65°, and still less than a rise from 65° to 70°. The rate of diarrhœal rise differs for different localities. In London, with a greater and earlier summer heat, we have a greater and earlier increase of mortality from diarrhœa; and with a lower and later summer heat, we have a less and later increase of the deaths from diarrhœa; and with a still lower and later summer heat, we have a still less and later mortality from bowel-complaints. The thirty years' curve for London shows that diarrhœa rises rapidly above its mean before the end of June, and by the beginning of July is 300 per cent. above its average. From this point it falls nearly as rapidly as it rose, and gets again below its mean in the middle of September. The curves for the rest of England and for Scotland, both rural and urban, are of a similar character, but no two years or two places are absolutely alike. The curves

[1] Transactions of the Sanitary Institute; Address by Dr. Arthur Mitchell, 1882-3.

for thrush, tabes mesenterica, enteritis, jaundice, etc., are of the same character as the curves for diarrhœa and dysentery, though less pronounced. "All the diseases of the viscera kill most in hot weather."

The result of the eight years' inquiry, given in a professional Report, by Dr. Ballard, of the Local Government Board, is "to formulate a truer and more definite judgment respecting the disease," the most fatal of all the zymotics, "than has before been attained."[1]

The chief points in Dr. Ballard's conclusions from this inquiry may be shortly stated as follows—

High air temperature is of much less influence than earth temperature, and high temperature at the surface or within 1 foot of the surface of less influence than the temperature at 4 feet in the earth. "The maximum diarrhœal mortality of the year is usually observed in the week in which the temperature recorded by the 4-foot earth thermometer attains its mean weekly maximum." The summer rise of diarrhœa does not commence until the mean temperature recorded by the 4-foot thermometer has attained somewhere about 56°, no matter what may have been the temperature previously attained by the atmosphere or recorded by the 1-foot thermometer.

Diarrhœa mortality is greater in dry than in wet seasons, especially if the drought is prolonged, and *vice versâ.*

Calm promotes, and high winds lessen, diarrhœa.

Elevation above sea-level, of itself, does not appear to be an important factor.

Where dwellings in a place have as their foundation solid rock, with little or no superincumbent loose material,

[1] *Public Health,* June 1889.

the diarrhœal mortality is low, and may be altogether unnoticeable. In other soils, diarrhœa is largely in proportion to the fineness and permeability of the material of the soil. Sand, and also surface mould of considerable depth, are the most diarrhœal soils. Gravel, if loose and fine, is favourable to diarrhœa; if approaching rock in its coarseness, unfavourable. Clay soils do not appear to be particularly diarrhœal. The presence of much organic matter in any soil renders it distinctly more favourable to high diarrhœal mortality than it would otherwise be. The mortality is high on made ground, the refuse of towns or the site of market-gardens, or where the earth beneath and about dwellings is polluted by neighbouring collections of liquid filth in cesspits, or where sewage has soaked into it from imperfect drains and sewers, or from the surface of the ground. It is the opportunities for the collection of organic filth in the fissures of certain kinds of rock that seem to impart, where towns are built upon them, a diarrhœal character.

Moderate dampness of soil is conducive to diarrhœa; much wetness or dryness unfavourable.

Density of population, and density of buildings, promote diarrhœa. Restrictions and impediments to the free circulation of air, about dwellings, and in dwellings, promote diarrhœa. The absence of free domestic ventilation increases very greatly and very obviously the mortality from diarrhœa. "Fustiness," dirtiness and darkness of dwellings, promotes diarrhœa. Sewer or cesspool emanations cause outbreaks of the disease. Filthy accumulations of domestic refuse, and even receptacles which have been emptied but are encrusted on the sides with filth, cause the disease.

Artificial feeding of infants contributes very largely to mortality from diarrhœa; those fed at the breast are remarkably exempt. Food kept in dark cellars, or stored in places exposed to emanations from filth, and not well ventilated, is likely to cause diarrhœa.

Dr. Ballard concludes—That the essential cause of diarrhœa resides ordinarily in the superficial layers of the earth, where it is intimately associated with the life processes of some micro-organisms not yet detected, captured, or isolated. That their vital manifestations are dependent, among other things, perhaps principally, upon conditions of season, and on the presence of dead organic matter, which is its pabulum. That on occasion they are capable of getting abroad from their primary habitat upon the earth, and having become air-borne, fasten on organic non-living material, use such organic material both as nidus and pabulum, in undergoing various phases of their life-history. That in food, inside as well as outside the human body, such micro-organism finds, especially at certain seasons, nidus and pabulum convenient for its development, multiplication, or evolution. That from food, and from the organic matter of various soils, it can manufacture a substance which is a virulent chemical poison, and that this chemical poison is, in the human body, the material cause of epidemic diarrhœa.

In some groups of cases, diarrhœa has been found to be directly communicable from person to person.

The fever districts, as Dr. Buchanan has remarked, are chiefly rural or small town districts; the diarrhœa districts are large towns.

Dr. Buck shows[1] that the three towns with the

[1] *Transactions of the Sanitary Institute,* 1885-86. "Infantile Diarrhœa." Dr. Buck.

largest amount of diarrhœa, namely Leicester, Preston, and Hull, were situated as follows—

Leicester; in a hole with a canalized river dammed up against it by mills and locks. A brook, held up by this river, is known to affect wells at a considerable distance.

Hull; the whole soil round Hull is alluvial clay, or warp of more recent deposits. This deposit is 4 to 10 feet in thickness, and lies upon silt, sand, or gravel. Natural drainage would be impossible, owing to the flatness of the area of the borough, were it not for the ebb and flow of the tide.

Preston; on clay soil with running springs in sand. Lower part of town black loamy soil, and underneath a marshy and peaty soil. Subsoil water 10 to 15 feet from surface, as at Leicester. Canal at higher elevation than river; also large cooling ponds.

Bristol, Huddersfield, Bath, and Rochdale have the lowest mortality, and are differently situated—Bristol on dry sandstone, with good deep and superficial drainage; Huddersfield on the slope of a hill above the Calne river, with good drainage. Bath and Rochdale are also well drained and situated. At Winchester, Mr. Power found the diarrhœal area to be the low-lying parts of the older city, in some places below the river-level.

Prior to 1850 diarrhœa does not seem to have been unduly prevalent at Leicester, but since that time the mortality has steadily increased, and the town is now well known as representing the highest rate among English cities.[1] By references to past records, it is proved that since 1850 the soil, especially in the older

[1] *Lancet*, July 27, 1889. Report on an Inquiry into the Etiology of Summer Diarrhœa, by Dr. Henry Tomkins.

parts, has been undergoing a constant pollution with organic filth from insufficient and defective sewers, which, "even up to the present day," are polluting the ground in which they are laid. A new scheme, however, is now being carried out, and the old privies and cesspits are almost all abolished. Until very recently, the low-lying parts of the borough were subject to periodical floodings by overflow from the river, itself not too clean, from all of which causes the soil of the older and lower parts of the town has been more or less polluted with organic filth. Diarrhœa does not prevail in Leicester to any marked degree until the earth at the depth of one foot has reached about 60° F., or about 56° at 4 feet deep. In 1888, this occurred in August, and then only did diarrhœa largely prevail. In some preceding years the earth temperature named was reached in July, and then the epidemic broke out correspondingly early. Leicester lies in the hollow of a valley, and in the confined streets the air is often stagnant. Much crass ignorance prevails in the management and feeding of infants. The bulk of the fatal cases occur among the weakly and ill-nourished. Cultivation of bacilli obtained from the affected districts induced diarrhœa within six hours after being swallowed.

In 1880, Dr. Johnston of Leicester suggested, "that the more immediate cause will be found, if I mistake not, to consist of fungoid impurities in the air, derived from the putrefaction of animal refuse." Dr. Tomkins, subsequently M. O. H. for Leicester, pursued this idea, and found by bacteriological examination of the air, that in one part of the town a cubic metre of air contained from 60 to 900 germs, while in another part a cubic metre contained from 2000 to 7000, consisting of micrococci and bacilli of various forms and sizes. This part, where the excess occurred, was the low-lying and flat district, having sewers which are too small, deficient in fall, and constantly liable to stagnant deposits and overflows. In this area, containing not more than one-third of the population of the town, 216 out of 256 deaths from diarrhœa took place. The most important feature of the investigation was the production of diarrhœa by the administration of a very small dose of the growths obtained from the air of the contaminated part of the town and from the internal organs, after cultivation for several generations.[1]

The general means of prevention of diarrhœa will probably consist in—1. Cleanliness in the surroundings and in the interior of houses. 2. Concrete or impervious flooring between the house and the ground, and prevention of building on tainted "made ground." 3. Uncontaminated water-supply. 4. Keeping food, and especially milk, in clean places, well ventilated, and not subject to emanations from dirty yards or drains. 5. Avoidance of decayed food, and milk kept more than a few hours. 6. Great care in the storing and transmission of milk, and cleanliness of cows and dairies. 7. Drying of ground and reduction of level of subsoil water; improvement of drainage of land, especially in and near cities. 8. Raising or drying of ground in low-lying parts of cities or near houses.

[1] *Public Health*, May 1888. Address by Dr. Alfred Hill.

DIPHTHERIA.

Diphtheria is an infectious specific disease, endemic in certain places, sometimes prevalent as an epidemic.[1] Diphtheria has greatly extended during the present century, and epidemics have occurred in countries far apart from one another, and differing essentially in physical features and climate. The increased geographical distribution is probably attributable to the increasing intercommunication of nations. Among places where diphtheria is endemic are or were Florence and Paris. Poverty and its concomitants predispose; dirty, unventilated dwellings and bad nourishment increase receptivity. Children between two and ten are most subject to it; it may attack, rarely, persons of all ages. Certain persons and families are more predisposed than others. Diphtheria of the air-passages frequently occurs as a secondary disease after a common sore throat. The incubation period is usually a few days, but may in some cases be much longer.

Dr. Tatham is convinced, in spite of the well-marked distinctions between diphtheria and scarlet fever, that these diseases are intimately related.[2] Dr. Bond, the Health Officer of Gloucester, adduced many proofs of this relationship in his reports. "Every year

[1] Sir J. Rose Cormack. Quain's Dictionary.

[2] *Health Journal*, January 1885.

tends to confirm in my mind the belief that though scarlatina generally originates from direct personal infection, and though typical diphtheria has often a purely local origin, especially from sewer emanations finding their way into houses, these diseases are due to an infection which in all cases attacks the throat, propagates itself mainly from the throat, and which may, in passing from one person to another, undergo such modifications as will give rise in one case to a characteristic outbreak of scarlatina; in another to an equally characteristic outbreak of diphtheria; and in a third to a mongrel type of affection which it is difficult to identify by any other than bad sore throat, and which is, in fact, a connecting link between them. Practically, the outcome of this view of the matter is to view with the greatest suspicion any case of sore throat, especially in young persons, and to assume that it is scarlatinoid in nature unless good reason can be shown for regarding it otherwise."[1]

It is scarcely necessary, says Dr. Tatham, to insist at the present day on the essential identity of membranous or true croup with diphtheria.

Diphtheria frequently supervenes as a secondary disease in cases of simple inflammatory sore throat, and of the sore throat of scarlatina or measles.[2] The common exciting causes of inflammations of the larynx and trachea are exposure to chilly winds and damp cold air, and sudden transitions from mild to cold wet weather.

Dr. King believes that diphtheria, although usually spread by the ordinary means of infection and by infected clothing, furniture, milk, and sewer gases, may

[1] Tenth Annual Report of the Gloucestershire Combined District.
[2] Sir John Rose Cormack. Quain's Dictionary.

be carried by the wind to distant places, such as farms situated on high ground; and that the surface of the throat may be the ground for the initial growth and development of the microbe.[1]

In relation to the development of diphtheria, it seems possible that the presence of other bacilli or their products may be necessary, as well as other conditions, to evolve malignant out of harmless or less malignant forms of bacilli morphologically indistinguishable.[2]

Dr. Schrevens, of Tournai, from observations conducted in Belgium in the ten years 1881-90, found that the two diseases, typhoid and diphtheria, were distributed in the same manner over the country, and that where one was severe the other was severe; but the diagrams constructed showed one exception, East Flanders, which Dr. Schrevens accounted for by the soil being there washed clean from impurities, owing to its wetness. The mortality is higher in the country districts where surface pollution is not removed as in towns. Moreover, certain fowls seem to have a great tendency to harbour the germs of diphtheria.[3]

Dr. Hewitt stated that in Minnesota diphtheria made its appearance in 1860, and is now the most common cause of death except two—the diarrhœa of infancy and tuberculosis. Diphtheria started among the families settled on the banks of the great streams, and for some time remained a family disease, owing to the isolation of these small settlements; but later, when

[1] *Sanitary Record*, January 15, 1881.

[2] Mr. Woodhead. Paper read at the meeting of the Epidemiological Society, April 15, 1891.

[3] International Congress of Hygiene, 1891.

the business of the country led to increased intercourse, it spread to the higher plains.

Dr. Bergeron stated that to combat diphtheria we can at present only employ isolation and disinfection; with regard to disinfection, all the emanations should be destroyed, and all fomites rigorously disinfected. Although we know nothing clearly, it seems that the disease is transmissible from the moment that the white pellicle makes its appearance, and that the incubation period is very short. It was the practice to isolate sufferers up to any period not exceeding six weeks. Schools should be closed.

Dr. Abbot, in a paper on diphtheria in Massachusetts, stated that the mortality of the dense districts being assumed as 1000, that of the moderately-dense was 803, and of the sparse 603. In the latter half of the period under review the towns suffered relatively more than the first half. When once introduced into a village, the opportunities of infection may be greater than in a town, for in a village every one knows his neighbour.

The spread of diphtheria in a country town occurred at a certain remote place in the following manner. A school-teacher returned home from another place with diphtheria. Within the next six months cases occurred among her family and relations. It entered the house of the family physician, and several deaths occurred. He left the town, and his house was vacant for some months. People went to and from the infected houses to the post-office, which was also a grocer's shop, and the grocer visited the houses with his groceries. His family was next attacked and broken up, and its members scattered. A new physician came to occupy the vacant house of his predecessor. Soon after moving in his children were attacked. A lying-in woman whom he attended, and her boy of seven, were both attacked; then a neighbour who called upon this woman; and so the disease extended for eighteen months.

Of the fifteen towns which stand at the head of the list as having an excessive diphtheria and croup mortality, five are small and contiguous towns in the north-west corner of the State, mainly inhabited by a sparse farming population, and thickly wooded. Florida, which had the highest rate, is a small and hilly town; Spencer, the second on the list, is situated mainly on a high hill, and had a population of 7466 in 1880.

Four towns had no deaths from diphtheria during the period. All of these are small towns. Their chief characteristic is *inaccessibility.* None of them are near a railway-line. One is cut off from the rest of the State by a high range of hills; another is a remote town on an island.

Dr. Abbot quotes from a paper presented at the American Public Health Association, in which the results of an inquiry into houses affected and unaffected by diphtheria, showed that the drainage, etc. were about equally bad in both, but that damp cellars preponderated in the proportion of eight to five in the houses attacked.

Dr. Abbot's experience has led him to several conclusions which are stated in his paper. The following among them, shortly put, are perhaps the most important. Diphtheria is an eminently contagious disease, and infectious directly and indirectly; it is propagated by soil-moisture, damp houses, and cellars; the poison may remain ineffective in houses for a long period.

These conclusions agree very well with English experience, which has proved diphtheria to be mainly spread by infection, to be favoured by damp houses, and to be absent from isolated places, such as the Scilly Isles, until the germ is brought by human agency. By a very important recent paper of Dr. Klein, it appears that diphtheria may be inoculated from the human subject into cows, with the effect of producing the modified disease in them, and that the milk of such cows produces a severe disease of the same nature in cats which consume it.[1]

These and other experiences with cattle, in connection with scarlet fever, appear to support the view of an intimate connection between scarlet fever and diphtheria. They point at least to a probable cause of many outbreaks of diphtheria and scarlet fever in the previous prevalence of a similar malady in milk cows and other animals.

An outbreak of diphtheritic tonsillitis at Eton College was traced with a great deal of probability to the access of the cows, yielding a certain supply of milk, to a sewage-poisoned ditch, where they drank. The milk may have been contaminated by the adherence of some of the water or mud to their udders, and the consequent development of the microbes in the milk. Only a very few such organisms may have been sufficient to cause the outbreak, for it was the milk which was kept overnight which was especially infective, and in this a very large multiplication of the special microbes would have taken place. Some scarlet fever prevailed in the town, to the sewage of which the cows had access.

In the recent Milroy lectures of Dr. Thorne Thorne,

[1] Nineteenth Report of the Local Government Board.

the conditions which develop and propagate diphtheria have been dealt with in a highly instructive manner. This disease has greatly and steadily increased in England, and especially in London. Dr. Longstaff showed that prior to 1860 the diphtheria rate for the sparse districts was double that for the dense districts; but for the period 1871-80 the rates of town and country came to be nearly equal. The mortality in towns in 1889 was 0·26 per 1000 against 0·14 in 1881. The broad geological features of the country have no direct influence in diphtheria mortality. But the highest rates of mortality do seem to prevail in certain positions and in certain climates; for instance, in the exposed portions of the north-eastern and eastern coasts, and in the damp valleys of Wales. Water upheld in clays and gravels, dampness, a cold bleak air, and vegetable decomposition, are favourable to the development of diphtheria. But other conditions often outweigh all considerations of climate and soil. A striking rise in diphtheria mortality takes place in October; this hardly abates in November. The number of outbreaks, however, seems to be greatest in September. Preceding marked diphtheria cases there are often many cases of sore throat, tonsillitis, etc., and often these mild throat cases were the connecting link between successive outbreaks of diphtheria. The minor throat ailments are infectious, and fatal diphtheria is often contracted from them. Dr. Thorne believes the disease to show a progressive increase and diminution of the property of infectiousness, in much the same way as special characteristics may be artificially developed in higher plant life, and as easily lost. With regard to the question of identity between scarlet fever and diphtheria, the explanation probably lies in the lesion of the fauces in scarlet fever affording a favourable soil for the reception of the diphtheria contagium. "Were it otherwise, the almost total absence of diphtheria as a complication of scarlatina among several thousand scarlatina patients at the London Fever Hospital would be inexplicable." The lesion of the fauces by ordinary sore throat and by that of measles affords the explanation of the frequency with which diphtheria follows in such cases. The abraded surface of the throat may be the very soil suitable for the inoculation of the diphtheria organism when present in the air. Drains may retain a diphtheria contagium, received through the sputa and ejecta of the sick. But the main influence of the drain effluvia may be by a preparation of a soil, by means of a morbid surface of the fauces, ready to receive and promote the development of the wandering organism.

The report of Mr. Adams, of Maidstone, was quoted by Dr. Thorne in reference to the outbreaks in that town, which Mr. Adams believed to be related to abnormal oscillations of subsoil water, which kept the soil damp, favoured decomposition of its organic contents, afforded a breeding-ground for specific organisms, and at frequently recurring intervals expelled from the soil into the atmosphere an air laden with these organisms.

He referred also to the researches of Oertel, which go to show that diphtheria is primarily a local disease, and that the general disease is altogether a secondary one due to infection of the system.

The outbreaks at Coggeshall, at Pirbright, and at Radwinter, and many others, show the very large influence which school attendance exercises in developing diphtheria. Mr. Power found that the disease appeared with startling suddenness and fatal gravity each time when the school reassembled; and it seemed that the mere bringing together of the children was responsible for imparting to the throat affection the serious specific quality in question. Similarly a case is recorded by Dr. Bruce Low, in which an outdoor school treat was held on a damp day in a tent, after a prevalence of throat-disease, the result being that the disease broke out again within twenty-four hours, with a virulence and fatality quite in excess of anything that had gone before.

It appears that in some persons who have apparently recovered from an attack of diphtheria, there is an obscure recrudescence of the disease, shown by patches on the tonsils and pharynx, and also by an infective quality, which is not accompanied by the general symptoms of suffering which accompany a primary attack. Such recrudescences were mostly associated with unwholesome surroundings of the same sort as those conditions which induced a form of sore throat, which rendered the subject especially liable to receive the diphtheria contagion, the tonsils in such a condition affording exceptionally suitable hosts for sustained maintenance of the virus of the disease.

The spread of diphtheria is favoured by schools especially through the closeness of the breathing organs to each other; and the excess of diphtheria among girls is explained by special reasons connected with their lessons and habits. The spread of diphtheria from children to nurses in hospitals has been prevented by a rule prohibiting the nurses from carrying the children in their arms. In some of the northern counties, diphtheria is often caught through the extremely culpable practice of bringing children to see and even kiss their dying school-mates.

There is, unfortunately, an inducement in schools to increase the average attendance by a "whip-up" of such children as may be absent from sore throat, etc., and this dangerous practice is often followed by an "explosion" of diphtheria.

The experiences of Dr. Michael Taylor, Dr. Ballard, Mr. Power, Dr. Klein, and others, show in the clearest manner that milk is often the vehicle of the contagium, and several epidemics of great severity and extent have been traced to the supply of milk from a particular dairy. Cows inoculated with diphtheria acquire a disease which may or may not be fatal. The udders and teats exhibit vesicles, "chafes," sores, etc., almost exactly like those found by Mr. Power and others on cows in the milk diphtheria epidemics. And in the lymph of these udder vesicles the true bacillus of diphtheria can be found. So also from the milk itself abundant colonies of the bacillus of diphtheria can be cultivated, whilst no other organisms can be detected. It accidentally happened in Dr. Klein's experiments that two cats were supplied with such milk. In these cats the disease called "cat diphtheria" resulted. "We are able," said Dr. Thorne, "to appreciate the import of those apparently trivial ailments in milch cows to which so little importance has hitherto been attached by veterinarians and dairymen, but which have so commonly been discovered in association with epidemics of milk diphtheria."

The connection of croup and diphtheria is becoming more and more accepted amongst English observers, and French and German authorities have long classified them as one disease. Oertel found that animals inoculated with diphtheritic membrane generally died in thirty or forty hours.[1]

Mr. Adams considers,[2] from his experience of the Maidstone epidemic, that "the nearest approach we have got to the discovery of a fundamental cause is to be found in the insanitary conditions of houses or their surroundings, more particularly in the foul states of the house-drains, etc., the soil adjacent thereto, and the noxious effluvia escaping by the sewer-ventilators, and given off from the retained sewage." The part played by sewer-gas from unflushed sewers with ventilators in the road close to cottages seems to be strongly made out. Mr. Adams endeavours to show that the natural habitat of the specific microbe is polluted surface soil and similar situations; that its propagation in the soil is due to suitable meteorological conditions, and that its reception in the animal body at least is favoured by certain pathological states, and perhaps other life conditions of environment, special to the organism itself, and determining its development and activity. It is noted that the keeping of pigs, poultry, rabbits, etc. is very common, and in many cases a veritable nuisance. The house-refuse, when not disposed of on the premises, is sometimes allowed to collect in large uncovered pits, often too near the houses. Dung is often deposited within a few yards of the houses, and the closets are often extremely foul from want of proper flushing. The house-drains become blocked with horribly offensive

[1] *Deutsche Medicinische Wochenschrift.*

[2] A Contribution to the Ætiology of Diphtheria. Matthew Adams, F.R.C.S., etc.

sewage, the soil sodden from escape at the badly constructed joints of drains. Three cases of outbreak of diphtheria in cottages in one street are especially instructive. The cottages have sunk basements, with drains which pass from house to house, underneath the floor of the basements, and having trapped gulleys within the houses; and this drain, after picking up the drainage of each of the six houses, finally passes from back to front to discharge into the main sewer. Each of the three houses attacked had their drains blocked, and their cellars flooded by sewage; none of the adjacent houses had either flooded cellars or cases of croup. Disturbance of polluted soil, and exposure to emanations from defective drains, sewage effluvia, closet nuisances, etc., seem to be associated with many localized outbreaks. But a *rapid spread* of diphtheria is usually caused by the infection of a school by a child or children suffering from sore throat of a diphtheritic character, or by the use of infected milk. In the Maidstone epidemic it was found some weeks afterwards that a child whose brothers and sisters were suffering from diphtheria, and who herself had a sore throat, continued to attend school. These early cases were all concealed, and no doctor was called in. A serious outbreak among the scholars took place about the very day of the commencement of the illness in this family.

Mr. Adams believes from observations carried on during several years, that the microbe of diphtheria may live on the soil, and flourish on dead or decaying animal matter. It is aerobic, requiring its proportion of moisture, heat, air, and albuminous food, and a position at or near the surface of polluted soil seems to him the most likely place to find these conditions fulfilled.

According to Dr. Thursfield,[1] it is now generally admitted that there is a very intimate connection between dampness and diphtheria. It is probable, he maintains, that diphtheria is becoming endemic in towns because it there meets with conditions favourable to its existence and its spread outside the body. There is exceedingly strong evidence that sewers may become specifically contaminated with the diphtheria germ; and Dr. Sykes has suggested that the slimy, unflushed, upper portions of a sewer would form an admirable cultivation field for this germ. Such a specifically contaminated sewer would only need a slight escape of sewer air and the presence of individuals with congested throats to produce diphtheria. Structural dampness of habitation is the condition most favourable to the incidence, the severity, and the spread of diphtheria, and to the persistent vitality of the germ. Mould and fungi flourish in damp houses, and these conditions not only produce in individuals a condition of system predisposing to diphtheria, but also a suitable nidus and resting-place for the germ outside the body. The disease is very apt to occur, even after years, in a house where it has once existed. "I would hesitate to put a limit to the time beyond which the revivification of the old germs should be considered improbable." Messrs. Roux and Yersin have found that the diphtheritic germ may, if protected from air and light, remain virulent for an almost indefinite time. The very large number of cases of diphtheria (about 2000) investigated by Dr. Thursfield, make his observations especially valuable. Personal infection is undoubtedly, he says, the chief means of

[1] Conference of Medical Officers of Health, Brighton, August 1890.

the spread of the disease, frequently by cases so mild as to be unsuspected links in "mysterious" outbreaks. A very large number of cases of sore throat in adults are contracted from well-marked cases of diphtheria, and these mild cases are often not kept indoors. Disastrous results have occurred through children absent from school, owing to slight illness, being whipped up unless able to produce a medical certificate. "In a considerable proportion of the cases where I have known diphtheria kill three or four children in a house, the children had suffered previously from whooping-cough, and had been whipped up to school almost as soon as they had been able to get out of the house." Sitting all day with wet shoes and stockings is a constant source of catarrhal sore throat, and over and over again those children who have sat long with wet feet are selected as the first subjects of diphtheria, especially if they have been tired with a long walk and then exposed to cold. The cases derived directly from animals are not very numerous, but diphtheria is very common in those parts of the country where almost every householder keeps a cow. Cats get the disease, which in them causes persistent coughing. There are instances of children catching it directly from cats which they nursed and carried about.[1] A good example of diphtheria caught from cats is recorded by Dr. Coleman, of Colorado, Texas, the patient being a child in a very remote and elevated spot. Two kittens which the boy had nursed, had died of an apparently similar disease. The question remains how the kittens were infected.

Dr. Turton gave an example of the importation of diphtheria in a flock of turkeys, brought to one of the

[1] *Lancet*, November 15, 1890.

Greek Islands, and Dr. Turner has given instances of contagion derived from pigeons.

Dr. Sykes considers that diphtheria occurs in all animals in a state of domestication, and in very many birds.

Cases described by Dr. Michael Taylor seemed to show that the dung of pigeons promoted diphtheria. Is it not very probable that the bacillus, which may be conveyed through the atmosphere, finds a nidus in excremental matter of animals, and thence invades the living body either directly or through contaminated milk?

Dr. Bruce Low's Report on the outbreak at East Haddon shows how severely a place may be punished for flagrant maladministration and neglect. "The 'Authority' pays its medical officer £5 a year, and his instructions are to undertake no inspections and make no special reports unless he receives notice to do so from the sanitary authority." Blocked drains; soakage of slops; pit-privies close to dwellings, long unemptied, and some close to wells; filthy pig-styes; "stinking" water-supplies; a crowded churchyard; close unventilated rooms, gave a highly favourable soil for the growth of diphtheria, which resulted in 134 cases and 20 deaths.

At Bromley, in Kent, a very fatal epidemic of diphtheria prevailed in 1876.[1] There were at that time a set of cottages called Eden Cottages, draining into cesspools, and dependent for water-supply upon a single surface-well in close proximity; on the other side of the road a set of houses called Wharton Terrace, with the same defects. Several cases of diphtheria occurred in

[1] *Sanitary Record*, May 4, 1877.

these cottages, which were the property of the inspector of nuisances and his father. Close by were five cottages called Zion Place, the property of a local builder, who was chairman of the Local Board. The old well here was condemned in 1875, but a new one was sunk very near it, within about twelve yards of a row of cesspools.

Mr. Elliston, Medical Officer for Ipswich, remarks[1] on the epidemic of 1889 in that town, that diphtheria had seldom been altogether absent in a sporadic form. "The etiology of diphtheria is becoming less obscure. There is every reason to believe that it results from the action of a specific poison, probably bacterial in nature, and may be associated with damp and badly-drained premises, dirty surroundings, and polluted water, whilst it is chiefly spread by the agency of schools, by milk, and by domestic animals and birds." The first cases in the first quarter of 1889, at Ipswich, occurred in a row of four close and badly-ventilated houses, badly drained, and with water-supply polluted by sewage. Several of the subsequent cases, occurring in different parts of the town, were not apparently connected with sanitary defects. When the disease broke out more extensively, it became necessary to close a school, and thereupon the epidemic form seemed to be lost. In eight cases investigated there was no apparent insanitary condition to account for them, but in nine others grave defects, such as badly-trapped house-drains, foul wet soil bins, and a polluted well, were found to exist. A number of deaths from croup took place in the same localities, and these children were under the same conditions as those who died from diphtheria.

In the report of the Medical Officer for Bolton for

[1] *Public Health*, October 1890.

1889, it is stated that diphtheria was very fatal. Defective drainage was found in several instances to have caused the disease.

In the report of the Medical Officer for Bournemouth for 1889, it is stated that two fatal cases of diphtheria were clearly associated with a particular milk-supply.

In the report of the Medical Officer for Portsmouth for 1889, Dr. Mumby states that thirty-three deaths from diphtheria took place; in fifty-one of the houses attacked, there were serious defects in drainage; in eight, distinct signs of dampness; five cases arose in one house from drinking impure water. A pet dog that had been nursed by a patient and had eaten food taken from the sick-room, was taken ill and found after death to have a distinct false membrane in the pharynx.

In a paper read by Dr. Sykes at a meeting of the Society of Medical Officers of Health on Dec. 21, 1888, cases were cited of sore throat following inhalation of sewer gas; and one of these apparently communicated diphtheria to a friend. Dr. Gwynne gave instances of mild sore throat increasing to diphtheria in a household; and Mr. St. Clair Shadwell gave similar instances. Also a case of a child suffering from diphtheria, a few days after being found asleep with its head resting on the grating over a man-hole. Professor Corfield believed in the possibility of development of diphtheria from simple sore throat. Dr. Sykes suggested that the apparently simple sore throat might itself be mild diphtheria.

The incubation period of diphtheria is usually from two to eight days.[1] A diphtheria case is infectious about three weeks. (This is increased or diminished in

[1] T. Sinclair Holden, M.D.

particular cases.) The disease appears to arise from filthy rubbish-heaps, near dwelling-houses, or accessible to children, or in the walls of a house which are damp, mouldy, and rotten, or where the house is surrounded by ditches or wet soil. Sewer gas and bad drains may easily communicate it. The infection of a person with diphtheria is given off in the breath. "At first it may be called a kind of infectious sore throat, and put down to the weather, until a severe or fatal case shows what it really is." Diphtheria has often been spread by milk.

No collections of refuse should be allowed to remain anywhere near the dwelling-house, or accessible to children. The contents of ashpits, privies, etc., should at no time be allowed to remain in heaps, but should be dug into the ground. No rubbish-heaps should be allowed to collect in waste places or back-yards. The ground-floor of houses should be higher than the outside. The sick-room should contain as little furniture as possible. Disinfection should be very thoroughly carried out, for the poison is apt to hang about for months.

Among many instances of the way in which diphtheria arises and spreads, the following may be cited—

In November 1883 a family, whose habits were extremely dirty, and whose rooms were foul and unventilated, with a filthy pig-stye close to the outer door, were attacked by the disease. The father, mother, a daughter aged seventeen, and a baby, died in succession. Shortly after their death a sale took place, and the undisinfected bedclothes, apparel, etc., were put up to auction.[1]

[1] *Sanitary Record*, September 15, 1885.

In January 1884, a farm-servant sickened of diphtheria and died. The wife of a cottager took some of the victim's linen to her own house to wash. On the next day diphtheria developed, and she died on February 4. Then seven of her nine children caught the infection, and six of these died. Of the two who escaped, one was lodged elsewhere, and the other was a young infant. A woman, who had been nursing the farmer's wife (who also died of the disease), was attacked three days later. Seven of her nine children were seized two days after the mother, the other two a few days later. One of the children of this family suffered a second time in June.

In October 1884, four of a family at Holcombe Regis were sufferers from diphtheria. A boy aged twelve slept with the lad first attacked, and remained in the house. He did not complain of sore throat, but his eyes were dull, and he had the same expression of face as those affected. He had violent headache, and afterwards complained of pain and weakness in his legs; his sight was affected. A son who came home for two nights did not suffer, but one of the family with whom he lived was seized with sore throat a few days after his return.

An instructive case of the transmission of diphtheria by clothes is related by Dr. Underhill. The linen of a child which had died of the disease was boiled, but the dress which he had worn when first attacked was only washed in lukewarm water and put away in a box. The dress was very nearly six months later taken out of the box and put on the child's sister. In three days the girl was attacked with diphtheria.

In a country house in Scotland, a visitor suffered from the disease after occupying a room in which a case of diphtheria had occurred eleven months before.[1] Instances like this show the persistence with which the infection clings to floor, walls, and furniture. The celerity of its transmission through the air by the patient's breath is shown by instances such as the following. A boy in the Hospital for Sick Children had advanced symptoms of diphtheria within thirty hours of the beginning of the disorder in a child occupying the next bed. Thus by merely breathing the air of a room in which a diphtheria case is incipient, the disease may be conveyed.

Instances have occurred in the United States where diphtheria was apparently spread by cats.[2] In an isolated house, where the sanitary conditions were good, three dead cats, which had been missing for some days, were found under the floor, and were held to account for an outbreak of the disease.

An epidemic of diphtheria occurred at Pittsburg, U.S., in 1877.[3] Out of 856 cases, there were 366 deaths. Dr. Snively, physician to the Board of Health, read a paper on the epidemic, in which he described the sewerage of the district in which it occurred as extremely defective; there was insufficient grade, absence of traps at street drops, private connection points, and main terminus, while the man-holes were tightly covered and there was no ventilation. Slaughter-houses drained without traps. One main was choked for a length exceeding 2000 feet. Heavy rains caused choking, and expulsion of sewer gas into houses.

1 Reynolds' *Medicine*. Article "Diphtheria."
2 *Sanitary Record*, March 15, 1891.
3 *Ibid.*, August 16, 1878.

A severe visitation of diphtheria at the village of Biddenden, in 1878, was apparently due to neglect of the inhabitants to comply with a recommendation made in 1875, to construct proper drainage. "This disease, like typhoid fever, diarrhœa, etc., is generated by filth in and about dwellings; it was not surprising to find that one or both of these conditions pervaded the whole village, and were in fact reported upon as dangerous during 1875."

An outbreak of diphtheria at Surbiton in 1878 was attributed by the medical officer to infected milk, thirty out of thirty-four cases taking their milk from the same dairy. Another outbreak at Surbiton, in 1890, was caused by the supply of milk from a very dirty farm in Hampshire, where a case of diphtheria had occurred, besides others in the village near which the farm was situated.

Several epidemics of diphtheria have been distinctly caused by particular supplies of milk.[1] In one case it was found that the well-water of the dairy was much contaminated with sewage, that the milk-cans were left to drain near an untrapped inlet to a house-drain, and that in the floor of the dairy was a gully leading to an unventilated drain. In another case, the water used in the dairy smelt offensively, and the pipe from the sink where the milk-cans were cleaned was not properly trapped and disconnected. In a third case, the water-supply was impure, and one of the cows had recently suffered from garget. In a fourth case, the milk-cans were kept near a sink with an untrapped pipe, and resting on the milk-cans were bundles of dirty linen from the bed of an infected child. One child at the

[1] *Transactions Social Science Association,* 1883. Ernest Hart.

farm had been ill with sore throat, and another child was in bed with diphtheria. In a fifth case, there was an extensive outbreak of sore throat coincidently with the illness of a cow with garget. Dairyman stated that the milk from this cow was thrown away, but he could not always tell when a cow was affected with the disease. In a sixth case, milk-cans were washed in an outhouse adjoining a w.c. and drain of next house, from which it was found, by the benzoline test, that air could penetrate into the outhouse. Case of diphtheria in this next house. In a seventh case, the water-supply of dairy was largely contaminated with sewage matter. In an eighth case, pond-water fouled by sewage was used for dairy purposes. The well-water used for washing milk-utensils was polluted by infective material of a previous case of diphtheria.

The above instances may suffice as indicating some of the conditions most favourable to the rise and spread of diphtheria. The Reports of Medical Officers for the last twenty years contain a large number of examples of different circumstances, nearly all connected plainly with filth in and around houses, damp, bad drains or sinks, or else with infection from person to person, in which diphtheria was developed.

According to Dr. Thursfield, who has specially studied diphtheria, the disease spreads solely through the ordinary channels of infection, and is not disseminated by means of mysterious atmospheric agencies, as is too frequently assumed.[1] "Under ordinary circumstances, it has seemed to me that diphtheria is a very tangible and controllable infection, and that the distance through which the infecting agencies can travel through the air without

[1] *Sanitary Record*, September 6, 1878.

becoming inert is very short." The infecting element is probably given off in chief from the throat with the breath, or with the expectoration, and may thus get conveyed to the sewer. There is reason, however, for the supposition that the drains may become infected through the excreta, and examples are not wanting of the disease attacking persons exposed to the emanations from drains known to have been subject to such contamination. "As regards its dissemination by sewer gas, diphtheria has seemed to me to follow exactly the same laws as typhoid fever, especially in the fact that they will both attack with greater virulence and readiness new-comers to an infected neighbourhood." "*The infection is most portable;* I have no doubt of it whatever. I have known it taken to a house by a person living in an infected house, but not at any time suffering herself, who went to visit a person a mile or two off, involving a considerable walk and a passage by ferry across a river, and only remained a short time in the house, but sufficiently long to leave the germ of diphtheria, which broke out a day or two afterwards. I have known it taken from one house to another a long distance off, and between which there was no other connection, or indeed any possible source of infection, by a woman who had simply been to fetch some yeast. Other remarkable instances I could give, if necessary." "I believe the infection to be specially liable to spread from a corpse." It will remain in unscavenged collections of excreta, and in the air of closed sewers, and will attach itself to articles of clothing and furniture, and most persistently to wall-facings. Of all diseases, this is the one most liable to be spread by schools. "I would suggest as a matter of ordinary practice, that as soon as any cases of infectious sore throat have occurred in connection with a day-school, that school should be closed for a sufficient number of days to cover the ordinary period of the incubation of the disease." "There are certain parts of the country where the disease may be said to be endemic, and where certain houses can be shown to have suffered repeated attacks at intervals of years. In such places an ordinary cold may be sufficient to give opportunity to the microbe to fasten, as it were, upon broken soil, and to start a fresh outbreak."

The present writer has known instances of the spread of diphtheria by conveyance through third persons; one in which a man reaching home after a long railway journey from a place where he had seen a friend suffering from the disease, communicated it to his daughter.

Diphtheria has long been known as an extremely infectious disease. It is now known[1] to be caused by a bacillus, which has been carefully investigated, and used to reproduce diphtheria in various animals. It manufactures a poison, which, injected into animals without the living microbes, gives rise to all the constitutional symptoms and lesions of the disease except the false membrane. "The evidence in favour of the specific infective Klebs-Löffler bacillus, is now almost overwhelming." Four-tenths of a millegramme of the diluted poison is sufficient to kill eight guinea-pigs.

It has been found that the bacillus can live in the mouth without immediately giving rise to diphtheria; the conditions requisite for its vigorous growth are inflamed tonsils, inflammation of the mucous membrane, sore throat, etc. This accords with the observed facts in connection with certain outbreaks of diphtheria.

[1] *Bacteria and their Products.* Sims Woodhead, 1891.

"Antiseptic throat-washes, not merely gargles, plenty of fresh air, and good nourishing food, are what are required" in such circumstances. Roux and Yersin have found that the specific bacterium may persist in the mouth for several days (in one case fourteen days) after all traces of the membrane have disappeared, and they advise that diphtheritic patients who are becoming convalescent should not be allowed to associate with their school-fellows or families for at least a fortnight after the membrane has disappeared, and that it is quite as important to wash the throat freely three or four times a day with disinfecting lotions as that the clothes and bed-linen should be thoroughly disinfected. The organisms retain their vitality in a room for six months, and probably longer. At high temperatures (33° C.) they do not live so long. When deprived of air, and protected from the light, they may continue capable of germinating for thirteen months. Being kept dry, and in the dark, is much more favourable to their vitality than exposure to light, with alternate moistening and desiccation. By far the best way of disinfecting clothes, the floors, walls, furniture, etc., is by the use of a liberal supply of boiling water.

The diphtheria bacillus attains a special power and virulence when it grows on the surface of the fauces, or outside the body altogether, when associated with the streptococci which occur in the throat in cases of scarlet fever, measles, and other diseases.[1] It is possible that other organisms outside the body may have the same effect in increasing the virulence of the microbe.

According to Messrs. Roux and Yersin[2] the attenu-

[1] *Bacteria and their Products.* Woodhead, 1891.

[2] *Annales de l'Institut Pasteur.* 1888, 1889, 1890.

ated virus of diphtheria is widely distributed, and readily regains its virulence. It is therefore necessary at the very commencement of simple forms of throat disease, and of those associated with measles and scarlatina, to practise careful and frequent swabbing of the throat with antiseptics.

Professor Oertel, who has made elaborate inquiries into the action of the diphtheritic microbe, also advises free disinfection of the pharynx. The disease is at first strictly local (in the throat), but in a few hours the poison produced spreads about the part affected, and in a few days may poison the whole body.

Löffler, the discoverer of the bacillus of diphtheria, concludes from his experiments that persons ill of diphtheria should not be allowed to mix with healthy people at an earlier date than eight days after the disappearance of all local mischief, and this should be especially insisted on in the case of children attending school.[1] The bacilli increase and multiply in milk, and therefore the sale of milk from dairies in which there are cases of diphtheria should be forbidden.

When diphtheria breaks out it is recommended by Professor Löffler, from the results of exhaustive researches on the effect of various drugs on the bacilli, that persons brought near sufferers from diphtheria should use a gargle of a solution of corrosive sublimate (perchloride of mercury) of a strength of 1 in 10,000 or 15,000, to be employed for five or ten seconds every three or four hours. Cyanide of mercury, 1 in 8000 or 10,000, is equally efficacious. Oil of eucalyptus, of citron, of lavender, also benzol and toluol, in the form of vapour, are useful.

[1] *Public Health*, March 1891.

According to Ewart and Simpson,[1] the pathogenic organism is a minute spore, which develops into long slender bacilli upon the surface of the tonsils, etc., when for any reason they are denuded of their superficial epithelium.

Observations by Dr. Formad showed that pigs fed on slops from a room where three or four children were sick with diphtheria, developed a serious disease, of which one died. A false membrane developed in the stomach, and was loaded with micrococci. These were seen attacking the leucocytes, etc. Inoculation of rabbits with these produced similar symptoms to those produced in them from human diphtheria. It seemed possible that the swine plague of the West might be the same malady.

The very large number of cases of diphtheria which occur in Paris and New York compared with London, is probably due to impure water, and especially to the susceptibility and infection produced by close rooms, as well as to improperly trapped drains, insufficiency of flushing, and surface filth.

In the Report of the Board of Health of New Jersey for 1888, diphtheria is stated to be the most formidable and fatal of the ordinary communicable diseases.[2] In Michigan, where the recommendations of the State Board of Health as to isolation and disinfection were fully carried out, there were only about one-fourth as many cases and deaths as in those outbreaks where these measures were not taken. In the 78 outbreaks in which isolation and disinfection were

[1] *Bacteria.* Magnin and Sternberg.

[2] State Board of Health, N. J., Twelfth Report, 1888.

both enforced, there was a saving of 160 lives and 721 cases.

The imperfect drainage arrangements, the contaminated water, the general attendance at crowded schools, the hot dry air of rooms, the rapid changes of temperature, and the nervous constitution, probably all have something to do with the wide and disastrous fatality of diphtheria in North America. Probably the farms have also much to answer for in their neglect of cleanliness and ventilation.

In a case of diphtheria[1] in a boy of four years of age, decayed grapes had been eaten and retained in the alimentary canal until severe throat symptoms developed. The boy recovered, but the ocular muscles were paralyzed. Dr. Power has found in his experience that unsanitary surroundings furnish all the conditions necessary to develop diphtheria.

Dr. Allen is of opinion that if such conditions do not *cause* the disease, they have a decided effect upon its severity and continuance. All his cases of the year were the result of infection, through visits of friends from another town, etc.

Dr. Gorham considered poor drainage to be the exciting cause.

Dr. Pettingil considered unsanitary conditions, except in cases of contagion, to be the cause of all cases.

A similar opinion was expressed by Drs. Anthoine, Hicks, Christie, Merrill, Colby, Graves, Wallace, Caverly, Holcombe, and more than sixty other physicians practising in New Hampshire.

Of 282 cases reported, ninety-two were attributed to

[1] Eighth Annual Report of the State Board of Health, New Hampshire, U.S.A., 1889.

unsanitary surroundings, sixteen to polluted drinking-water, twelve to contagion, thirteen to defective drainage, six to emanations from cesspools, four to filth, three to damp cellars, two each to swampy land about buildings, decaying vegetable matter in cellars, sink-drain discharging into cellar, and filthy pig-sty. Fifteen physicians reported that, in seventy-four cases, they could discover no cause, and in the remaining cases no mention of cause was made. Seventy-five physicians reported their opinion that unsanitary conditions have a decided influence upon the disease, either as the direct cause or as the means of developing the specific germ or poison; nine believe the relation of unsanitary conditions and diphtheria to be that of cause and effect; three assign filth as a cause; four attribute it to a specific germ or poison; four believe that unsanitary conditions have little or no connection with the disease; while two are undecided; and two attribute the cause to cold and impure air.

In one very malignant case in Westmoreland, U.S., the window of the victim, who died in seventy-two hours, was directly over ground completely saturated with the kitchen drainage discharged upon it by a wooden spout.

In another case a child was taken ill with diphtheria a week after moving into a house, the sink-pipe of which was connected with a cesspool which was air-tight, and the kitchen was almost unbearably foul-smelling. Other cases occurred in dirty houses where water was standing in the cellars.

In other cases the vault (cesspool) had not been emptied for two years; a horrid smell pervaded the whole house. Both families had recently moved in.

Dr. Charles W. Earle arrived at the following conclusions regarding the incidence of diphtheria[1]—It occurs in the mountains and prairies of the great new North-West with the same malignancy as in cities; it takes place with equal virulence in vicinities remote from sewers; once present, the inhabitants living on damp soil or over cellars containing decomposing vegetables, or in proximity to manure-heaps or poorly constructed sewers, seem to have the malady with increased severity; the contagious element is transported thousands of miles, and testimony is abundant as to the part played by steamers and cars; the disease is so contagious, and isolation so neglected, that the only method of prevention would be to enact laws casting some responsibility for contagious diseases on the people.

The difficulty of dealing with diphtheria among semi-civilized or barbarous people is well illustrated by a paper by a Russian doctor, on his experience of an outbreak in a Russian village of about 4000 inhabitants. Many refused his services, believing him to be unorthodox, even after he had consumed in their presence a consecrated wafer sent him by the local priest. All sorts of superstitions and prejudices stood in the way against him, and the peasants refused to believe in the infectiousness of the disease. They freely visited the homes stricken with diphtheria, kissing the diseased, wiping a healthy child's nose with the hand which had just been used for the same purpose on a diphtheritic child; giving a healthy child a biscuit left unfinished by a diseased one; washing diphtheritic linen in the wells from which drinking-water was derived, etc. The

[1] Ninth International Medical Congress at Washington.

disease consequently spread with the greatest rapidity and fatality.

The enormous extent to which infectious disease prevails in Russia is easily explained by a realization of such habits. A vast empire, of which the village population is sunk in the depths of ignorance and dirt, must be a constant source of disease to other countries. The rates of mortality and sickness are excessively high.

The seasonal curves of diphtheria and croup for the years 1855-80 seem to show a close relationship between these two diseases, a relationship now generally acknowledged as amounting almost to identity.[1] Both are found to vary to some extent inversely, as the amount of rainfall. Laryngitis follows very much the curves for diphtheria and croup. The distribution of diphtheria over England was peculiar in the period under review. It existed to an excessive degree in Wales, in Norfolk, and in Sussex. It does not appear that the disease is greatly in excess on clay soils, and the districts where diphtheria is very scarce are also partly on clay. But a heavy clay, dampness, and a confined situation seem to be somewhat pernicious. Of course the main factor is always the sanitary condition, especially, in all probability, the condition of farms and water-supply.

Dr. Davidson, in an interesting paper,[2] relates his experience in Buenos Ayres as showing the disease to be very frequently associated with a like complaint in hens.

Until the last few years, the maximum of diphtheria death-rates has occurred in sparsely-inhabited districts, and in moderately populous districts there has been a proportional excess in the rate over that of the densely-

[1] Longstaff's *Studies in Statistics.* [2] *British Medical Journal.*

populated. This is a very remarkable circumstance, and distinguishes diphtheria from other infectious diseases. It certainly seems to point to some disease of animals, probably springing from the very filthy condition of farm-yards, as a frequent intermediate source of infection to mankind. Possibly it may often be associated with the manure-heap to which poultry and other animals have access. The diphtheria microbe, though cultivated in filth and dampness, appears to thrive where exposed to a fine dry air, and does not apparently perish through exposure to light.

The disease often seems to occur in children as a consequence of playing on heaps of ashes, refuse, and manure; and as far as the present writer has been able to observe, the manure-heap seems to be responsible for some throat disease in poultry.

Experiments made by Messrs. Roux and Yersin[1] have led to conclusions, among which the following may be here concisely noted—

Mild cases of angina, and abortive croup, are diphtheritic, and in one case the bacillus was found to be attenuated, in another of moderate virulence. In recoveries, the virulent bacilli diminish and are gradually replaced by non-virulent bacilli. The pseudo-bacillus of diphtheria is common in the mouths of healthy persons. It occurs often in patients with sore throats, and with measles; but only in scarlet fever was it found in large numbers. Inoculation proved its innocent nature in animals, but in guinea-pigs it may sometimes cause considerable œdema. The distinction we make between virulent and non-virulent is arbitrary; it depends on the receptivity of guinea-pigs.

[1] *Public Health*, January 1891.

There are various degrees of virulence in both pseudo-diphtheritic and in diphtheritic bacilli. Some of the latter kill in twenty-four, some in sixty hours, some in three or four days, or longer; yet it occurs to no one that these are of different species. Why, then, separate those which only differ by a still less virulence? The relations between the "pseudo" and the "true" diphtheritic bacillus are probably of the same order as those which exist between virulent and much attenuated bacteria. The bacillus of diphtheria increases abundantly in broth at 35°, through which air is aspirated, and after a month is found to be attenuated so as no longer to kill guinea-pigs. By another more rapid method, desiccation and air, attenuation is obtained in a few days. This microbe, artificially prepared, is similar to pseudo-diphtheritic bacillus. The authors had previously shown that the toxine produced by the cultivated diphtheria bacillus produces in animals all the symptoms and lesions of diphtheritic poisoning. "All our experiments show that the toxigenous property of the bacilli varies according to their virulence, being at the minimum in very attenuated bacilli and in the pseudo-diphtheritic bacillus; notwithstanding, animals which receive large quantities of the filtered cultures of these non-virulent bacilli become thin, and a few die."

The feeble bacilli can be rendered virulent again by associating them with those of the most active erysipelas; separately, these were incapable of killing guinea-pigs; together, they were rapidly fatal, and the diphtheritic bacilli thenceforward had an increased virulence. "One may imagine that in certain cases the diphtheria which complicates measles or scarlet fever may have for origin the non-virulent bacilli often present in the mouth.

This is a mere hypothesis, but the foregoing experiments give it some basis. Most cases of diphtheria are certainly due to direct contagion, either from fresh or dried virus."

The authors conclude that the diphtheritic virus preserves itself for a long time in the mouth after the patient is cured; hence the bearers of these bacilli should be isolated a sufficient time. Dry virus is preserved for a long time; hence it is necessary to disinfect linen and all matters which have been exposed to infection. The attenuated virus is widely diffused; it may recover its virulence; hence, from the commencement of simple sore throats, and scarlatina, and measles, it is necessary to practise antiseptic treatment of the throat.

DYSENTERY.

Dysentery is a malarious disease which increases and decreases with the same conditions which give rise to malaria.[1] In the tropics and hot countries, in Great Britain, North America, and many other parts of the world, its diminution has proceeded *pari passu* with that of malarious fever. When intermittents and remittents have been extinguished by drainage or the cultivation of marsh land, dysentery has become equally unknown. Dysentery, in malarious places, is induced by unwholesome drinking-water; bad, unwholesome, or

[1] Quain's Dictionary.

indigestible food; exposure to large variations of temperature, and impure air. It does not appear to be directly infectious or contagious, but "the complete disinfection or destruction of the alvine evacuations should always be regarded as a sanitary measure of supreme importance."[1]

Dysentery, according to Griffiths,[2] is a specific disease, due most probably to a microbe. The disease is often epidemic, and sometimes sporadic. Moisture in the air favours its development, and spreads it. Contaminated drinking-water spreads the disease.

It is probably a disease which can be to a very great extent prevented. The losses by dysentery in the British army abroad have been enormous; but since the importance of pure drinking-water—or, at least, sterilized water—and dry, airy sites, and also the importance of avoiding over-fatigue in marches, and insufficient and improper food, has been recognized, there is no reason why the mortality and incapacity should not continuously diminish.

There seems little doubt of the correctness of the opinion, which is as old as Cullen, that dysentery and diarrhœa are produced by the effluvia of putrefying animal substances.[3] The gases from sewers and sewage, and from the bilge-water in ships will also sometimes cause it. In India there is a relation between the prevalence of dysentery and overcrowding and want of ventilation in barracks. The air from very foul latrines has been a cause in numerous cases. In the Cumber-

[1] The opening of a drain at Malta was followed not only by an outbreak of typhoid fever, but by simultaneous cases of diarrhœa, dysentery, pyrexial and intestinal disorders. *Army Medical Reports*, 1861. Dr. Marston.

[2] *Micro-organisms.*

[3] *Practical Hygiene*, Parkes.

land Asylum dysentery was preceded by nights which were nearly calm, with a gentle movement of the air from sewage 300 yards away in the direction of the ward. There appears to be good reason for regarding dysenteric excreta as specially capable of setting up the disease in others, where the latrines are unclean. A scorbutic taint plays a large part in the production of dysentery; and often improper or excessive food causes diarrhœa which passes into dysentery.

The death-rate of Julpigoree jail was no less than 24·66 per cent. in 1875, in spite of many precautions as to site, water-supply, overcrowding, ventilation, diet, labour, and conservancy.[1] No satisfactory solution was discovered for the extraordinary unhealthiness of this jail, which for a long time took a singularly high place in every class of disease except fever. The Report states that the drinking-water was brought daily fresh and pure from the Teesta river; but we may well conjecture that unsuspected causes of contamination were at work in the upper course of this stream. Dysentery and diarrhœa were most fatal, causing twenty-one out of thirty-seven deaths.

The Bengal Presidency jail, under different conditions, was also very unhealthy. It was overcrowded, a large quantity of filth was deposited by a tidal drain close to the walls, and there were 834 cases of dysentery and diarrhœa per 1000.

At Midnapore, in every respect apparently well cared for and healthy, the two jails had a heavy mortality, while at Pooree, "in the midst of a pestiferous town, and within a few feet of the large cholera

[1] Report of Sanitary Measures in India in 1875-6. Vol. ix. pp. 13 and 81.

hospital, annually filled with hundreds of dying pilgrims, and across which the sea-breeze blows straight into the jail," in 1874 no death occurred; in 1875 a mortality of only ·76 per cent. Possibly the sea-breeze is sufficient to account for the non-effectiveness of pestilential emanations here.

In some jails pneumonia, apparently infectious, was very fatal.

The Sanitary Commissioner for Burmah makes an instructive observation on the bad effect of overcrowding, even where ventilation is carefully attended to—"No matter how good the ventilation may be, any amount of floor-space under thirty-six superficial feet per prisoner is insufficient for the maintenance of health."

ERYSIPELAS.

Erysipelas occasionally occurs in the surgical wards of hospitals, and is then often transmitted from patient to patient.[1] The prevalence of erysipelas is connected with impure air and overcrowding. It has been somewhat frequent in fixed hospitals, but is exceedingly rare in tents and huts. When hospital erysipelas has once appeared in a ward, nothing will avail except complete clearance of the ward, scraping floors and walls, washing with chloride of lime, and then with solution of caustic lime, and thorough fumigation with chlorine and nitrous acid alternately. Extreme care in conservancy of wards and tents, the immediate removal of all dressings, great

[1] *Practical Hygiene*, Parkes.

care in dressing wounds, so that neither by instruments, sponges, lint, or other appliances, pus cells or molecular organic matter shall be inoculated, are matters of familiar hospital hygiene. There must be some abrasion or wound for inoculation to take place, and the erysipelas commences at the point of abrasion. "Is it possible that some forms of tonsillitis and diphtheritic-like inflammation of the throat may be caused in this way, although there is no solution of continuity?"

Hospital Gangrene, to which most of the above remarks apply, is prevented by perfectly free ventilation. The organic matter causing gangrene clings to walls with great tenacity. It not only does not occur in tents, but patients removed to tents at once commence to improve.

Erysipelas and Pyæmia. Mr. H. Burdett, in a paper on the unhealthiness of public institutions, cites the case of the Manchester Infirmary, declared by Mr. N. Radcliffe to be unhealthy from cellar to garret.[1] Outbreaks of pyæmia, erysipelas, and other traumatic affections, had shown during a series of years that something must be wrong. Sewer-gas has been proved to be a cause of erysipelas, and has now been shown to be a cause of much pyæmia in hospitals. Pyæmia occurred, affecting thirty patients in a few weeks, in the chief surgical ward of a large hospital; the sewers were unventilated, and all soil-pipes in direct communication with the sewer. No sooner were these defects remedied than pyæmia entirely disappeared. No other cases occurred for six months, when, all of a sudden, the disease appeared again in a virulent form. As it continued, the ventilating-shafts from the soil-pipes were

[1] *Transactions of the Sanitary Institute,* 1879.

examined carefully, and it was discovered that they were stopped up; some workmen had been engaged on the roof, and as they objected to the smell from the ventilators, they had closed them with pieces of rag. This being put right, the disease almost disappeared during two whole years. Mr. Burdett is convinced that but for the antiseptic system, several of the older hospitals must have been closed long ago.

At Frome, in the County Lunatic Asylum, thirty-two cases of erysipelas occurred among the inmates from December 1878 to May 1879, and nine persons died of the disease. Complaints of ill-health were made by very many other patients. Nausea, headache, malaise, sore throat, were long prevalent, and were followed by an epidemic of diarrhœa. Bad smells were noticed in all parts of the building. Investigations led to the following discoveries—None of the soil-pipes were ventilated, several were rat-eaten, and riddled with holes. A hole in a soil-pipe 3 in. by 1½ in. This pipe communicated directly into the main sewer. The main drain had been choked several times.

Cases of erysipelas occurred in Scotton, after an epidemic of pneumonia apparently connected with faulty drainage.[1] In these the inlets to drains were unprotected or untrapped.

The micrococcus of erysipelas has, through artificial cultivation, been found capable of setting up the disease in men and animals.[2] The incubation of the disease is from three to ten days. A 3 per cent solution of phenol destroys the micrococcus (Fehleisen), and a 2·5 solution of natural salicylic acid has a similar action.

[1] *Public Health*, March 1891. [2] *Micro-organisms*, Griffiths.

Erysipelas is undoubtedly infectious and inoculable.[1] Overcrowding in hospitals, want of ventilation, dirt of all kinds, bad food and water, are all predisposing causes. The type of erysipelas varies in different outbreaks. The incubation is from a few days to two weeks. Erysipelas does not protect against another attack of the same disease. "Erysipelas, under its own name, kills about 5000 a year, and under other names, perhaps many more."[2] It has two forms not distinguished on the registers, and probably not essentially different. One particularly belongs to surgical practice as a very serious complication of wounds. "The poison of this traumatic erysipelas seems to be identical with that of puerperal fever. Intimately associated with the atmosphere which breeds it, are other calamitous influences which are apt to prevail with erysipelas epidemically in the wards of ill-kept hospitals, threatening every open wound of every patient who lies there, arresting the vital processes of repair and putrefying its material, infecting the whole blood with mischief propagated from the part, converting slight injuries into grave dangers, and often defeating the success of the best performed surgical operations." In the old Hôtel Dieu, in Howard's time, "hardly any acute cases, childbed cases, or capital operations survived," and the operation of trepanning was laid aside as one which for fifty years had never been known to succeed. The old hospital ship *Dreadnought* had likewise an evil reputation, owing no doubt in part to its ill-adaptedness for a hospital, but partly and probably very largely to the organic contamination of the

[1] Quain's Dictionary. Article by Dr. Beck.

[2] *Public Health Reports*, vol. i. Sir John Simon. Report of 1858.

wooden walls.[1] In 1857, another more commodious ship was substituted for the *Dreadnought*, and the rate of fatal results of amputation fell from nine in twenty-two to one in sixteen; erysipelas and hospital-gangrene, which had been very common, were scarcely seen at all, and when introduced did not spread as before.

Erysipelas not associated with wounds appears to arise so often under circumstances of local unwholesomeness that Sir John Simon was disposed to believe that there is little essential difference between this form, which begins as a febrile attack, and the other form, which begins as a local affection; "and as the latter is unquestionably due to defective sanitary conditions, so I have strong suspicion that the former will be found a very infrequent disease when the causes of other endemic contagions have become less rife."

There can be no doubt that hygienic conditions are of the first importance in both forms of the disease, and good bodily health with good air and plenty of ventilation are the main securities against infection. The utmost cleanliness and care in every particular are requisite wherever a case of erysipelas exists, and similar precautions are demanded from all concerned, as in pyæmia and puerperal fever.

[1] Sir G. Blane on the *Prevalence of Different Diseases in London.*

GLANDERS.

Glanders, or Farcy, is a dangerous disease of horses, easily transmissible to man. According to Löffler and Schutz, the bacillus resembles that of tubercle. Dr. Finger, of Vienna, has, after a long series of researches, arrived at the following conclusions,[1] among others—

Successive local injections of the bacilli of glanders into animals susceptible to the poison produce with each injection symptoms of gradually diminishing virulence. Intravenous injection of virulent cultures quickly cause death to some animals. Intravenous injection of a sterilized culture of the bacilli of glanders produces in rabbits an immunity against the infection from pure cultures, which lasts from three to six weeks. Local manifestations, however, occasionally appear. Rabbits which survive an ordinary attack of the disease enjoy afterwards complete immunity. The immunity is not transmitted to offspring. Injection of sterilized cultures produces effects of poison, sometimes so severe as to kill. Post-mortem examination shows lesions as of the disease itself. If sterilized and virulent cultures are injected at the same time, the disease produced is exceedingly rapid and fatal.[2] The bacilli when introduced into the tissues of susceptible

[1] *Lancet*, June 20, 1891.

[2] Thus the poison prepares the way for the bacilli.

animals exhibit great activity, multiplying rapidly, and apparently defying the action of the phagocytes. In the tissue of non-susceptible animals, they show no signs of activity, but rapidly die and disappear. In rabbits which have been artificially rendered proof, they seem to take longer in disappearing. There is a rapid collection of leucocytes. The rapid death of the bacilli in white mice is probably to be referred to an active power of destruction possessed by the organism.

The slower disappearance in other animals is to be referred to the action of the leucocytes. But the fluid of the tissues themselves seems to play a prominent part in the destruction of the microbes.

Glanders is caught in stables by contact of a cut or wound with the matter from a glandered horse. It has been known to pass by infection from man to man.

Legislation has helped to reduce the prevalence of glanders; but it was stated at a recent meeting (Oct. 30, 1891), that about 2000 horses perish annually of farcy or glanders in London, and a proposal was made that farcied and glandered horses should alike be slaughtered on the same terms as cattle affected with pleuro-pneumonia. It was shown that glanders (or farcy) had been stamped out in the army, and one speaker contended that horses liable to be drafted for army purposes should be similarly dealt with in order to avoid the great losses which would be caused by the introduction of the disease into the cavalry. A measure for providing for the detection and slaughter of glandered horses would clearly be beneficial both for horses and men. At present the law permitted any one to keep farcied horses on his premises as long as he liked.

INFLUENZA.

INFLUENZA is now definitely proved to be an infectious disease, spreading from person to person, and country to country, much as some other familiar zymotics would spread among a population not rendered immune by previous attacks. The rapidity of its progress is due to three qualities—the short period of incubation, the large proportion of highly susceptible persons, and the long striking distance in impure air. The shortness of the period of incubation, from twenty-four hours or less to four or five days, would not be sufficient to account for the quick successive prostration of large numbers of people, unless combined with a high diffusive power, probably somewhat less than that of small-pox and greater than that of diphtheria, which produces the epidemic phenomena which have erroneously been spoken of as "mysterious."[1] It seems that something like a third of the people of most countries of Europe are susceptible to influenza under ordinary conditions. This is about the proportion which is usually subject to several other infectious diseases visiting a community for the first time. A very

[1] Dr. G. Buchanan, of the Local Government Board, has stated that owing to the short incubation period, influenza can give rise to 1000 attacks in the time that small-pox or typhus has taken to produce ten.

persistent notion has largely prevailed, even up to and through the epidemic of 1890, that influenza is not infectious, but conveyed by the general atmosphere or winds. This is the more remarkable, in that there is not any epidemic or disease of the nature of a specific fever known to be so communicated through long distances, and that a similar belief has prevailed concerning a number of other contagious or infectious maladies, *e.g.* cholera, rabies, consumption, and has always been finally overthrown. The evidence of meteorological facts, especially relating to the manner of the distribution of winds and material borne by upper or lower currents would have been very unfavourable to the maintenance of this opinion. In 1832, the epidemic of influenza occupied eight months in traversing Germany. No weather conditions or air-borne dust could travel so leisurely.

The reasons given below[1] appeared to the author sufficiently strong to establish the belief in the dependence of influenza on human communications, but a very large mass of decisive evidence has since been accumulated.

"The view expressed in your article of Jan. 11, respecting the infectiousness of the present epidemic is borne out by the following considerations, which tend to show that the atmosphere, far from favouring the spread of the disease, is in reality the great reservoir of purifying agents, however ill treated by human offending—

"1. The medical men of the eighteenth century were agreed that influenza is contagious. (Tenth Annual Report of the Registrar-General, 1847.)

"2. It spreads first and chiefly along the lines of

[1] *Daily News*, Jan. 15, 1890.

commerce—*e.g.* from China to Russia overland, and from port to port.

"3. It spreads much more rapidly where there are railways than where there are none, and where communication is by steamships than where only sailing-ships touch. Its first appearance in one large town after another corresponds fairly well with the interval between the maximum of the epidemic in the place of first appearance and the arrival of passengers and goods in the next place, whatever be the means of communication—caravan, railway, or steamer. This proportion would not be observed if the winds were the chief vehicle of the poison.

"4. The first cases in large towns are among people who have had either correspondence with places already affected, or parcels or goods from such places, or have been near, consciously or unconsciously, persons lately arrived, still infectious in themselves or their clothes.

"5. Large bodies of people working in a close, confined air, are the first and the most affected. This is easily intelligible if the infective matter be disseminated through such closed spaces from one or more cases among the attendants, but it is not intelligible if the whole atmosphere be permeated by it, for then we should expect an equal proportion of persons to be attacked in whatever building or district they lived.

"6. The spread of influenza last century, whenever it occurred, was much slower than it is at present; it took several months[1] to cross Europe. If the infective matter be in the atmosphere generally over large areas this would not be intelligible; but if it depends for its spread mainly on human intercourse it is exactly what might be expected, for the conveyance must depend on the facilities of travel.

"7. Some of the earliest cases in this country were

[1] Several epidemics occupied about two years in spreading through civilized countries.

in colleges or institutions keeping up continual communication with France, Germany, or Russia, while large numbers of isolated persons, as in prisons, seem to have escaped not only in this but in former epidemics.

"8. Although the wind blew on many days from the direction of infected countries, there was no appreciable effect upon English towns, and there was a total absence of anything like simultaneous seizure all over Great Britain, which would have occurred if the cause had been atmospheric, and not dependent upon human communication.

"9. The progress of the malady is from large centres to suburbs and villages, and then to isolated houses, which would occur by the normal transmission through contagion or infection, but would not occur if the general atmosphere were the chief carrier. The exceptions to this progression have taken place where either persons or things have come from places already invaded, or, in fact, where the isolation[1] has not been complete. But it does not seem improbable that rarely a case may arise from particles disseminated by the wind, as in more serious maladies.

"10. The instances of catching from one to another in families are very numerous, but there are always a number of persons who are not susceptible, as in measles or scarlet fever, and this immunity hides the infectious character.

"The atmospheric theory is the counsel of despair, but the realization of the dependence of epidemics of all kinds on human intercourse at once gives the assured hope of restraining them within narrow limits, as has been done in the case of the plague and other serious pestilences among men and animals. A knowledge of their origin and causes, as well as of their means of spreading, gives the power of almost or completely extinguishing them, as the ague of the fens, and the typhus of our large towns, have been extinguished.

[1] Before the arrival of the epidemic in the neighbourhood.

Without transplantation, exotic fevers would no more flourish among our population than the Canadian weed would have thriven in our rivers. But at least it is a satisfaction to see how the sanitation of our towns has reduced the severity of an epidemic like the present, for to those smitten with the fever, nothing is more important than an atmosphere free from such contamination as corrupts the streets of many foreign cities. A persistence on the same lines and increased vigilance will be the best security against the more serious epidemics which have on former occasions sometimes followed in the wake of influenza. Other diseases would, at the same time, be reduced, and much loss avoided."

In *The Times* of Jan. 7, 1890, the author suggested the possibility of a connection of influenza with the great floods in China in 1888 and 1889, by which a population estimated by millions had been drowned, and a densely-inhabited tract, with rich, highly-manured soil, had been covered with water which only slowly subsided. The area inundated was estimated to be as large as Wales. Great distress and famine followed the floods among the people crowded into the villages above their devastated fields. There appeared to be some connection between previous inundations and epidemics of influenza, but the records were too meagre to warrant more than inquiry. At the same time, the intensely infectious character of influenza was noted; and its rapid spread through a town or country from a few cases by the extreme minuteness and diffusibility of the microbes, and the short period of incubation, seemed to be fully accounted for. A large population was never really attacked simultaneously, as the old records averred.

The recent very valuable Report by Dr. Parsons, of the Local Government Board, contains statements, of which it is difficult to estimate the weight, partly anonymous and partly by correspondents, to the effect that influenza prevailed in Greenland in May 1889, and in Athabasca and other parts of British North America in the same month.

Curiously enough, in the same month, according to testimony which seems indubitable,[1] influenza prevailed in Bokhara; and the conditions under which it arose, seem to justify us in regarding Bokhara as the definite starting-place of the disease. The reported outbreaks in Greenland and Athabasca may be compared with the alleged extraordinary twilight phenomena which, in a very few places, were said to have preceded the great march of the strange phenomena which began in the eruption of Krakatoa in 1883. When attention is called to a succession of uncommon experiences following an uncommon event, we may expect that phenomena to some degree resembling these, but in reality only excessive manifestations of phenomena of common occurrence, will be brought forward as belonging to the train of events which have excited remark.

But the case of Bokhara does not belong to these doubtful items, and the course of events there, according to a writer in *Unsere Zeit*, was, succinctly stated, somewhat as follows—

Exceptionally hot and dry summer in 1888.

Bitterly cold winter and rainy spring.

Cracks and holes in the dried-up earth filled so as to form ponds; and country turned into a perfect marsh.

Hot weather set in; water giving off poisonous exhalations; malaria general, and unusually early.

People weak from want of nourishment; fast of Ramadan.

[1] P. 14 of the Local Government Board Report.

Town crowded with people, cattle, sheep, etc., between walls.

Sudden outbreak of influenza; many people died; Russian officials affected; many hurried home to different parts of Russia (July).[1]

Epidemic travelled westwards along the Central Asian Railway, and broke out in St. Petersburg in October. Caravans travelling eastward, from Bokhara to Siberia, conveyed the disease to post stations along the road.

Tomsk in Siberia was reached on Oct. 27 (new style), the Caucasus on Nov. 12, Viatka on Nov. 13; and by this time Riga, Pskov, Wilna, Kaluga, Moscow, and Sebastopol were affected. It was estimated that by the end of November half the inhabitants of St. Petersburg had been attacked. On Dec. 25 it was prevalent at Merv. The earliest cases reported in Denmark were on Dec. 7; in Stockholm, Dec. 9; in Christiania before Dec. 28; in Berlin at the end of November; in many districts in Germany about the middle of December; at Davos-platz (largely) about Dec. 26; in Vienna at the end of November; on Dec. 15 at Belgrade; at Constantinople before Dec. 29; in Belgium before Dec. 13; in Paris about Nov. 17; in Italy on Dec. 15; in Spain in the middle of December; in Portugal on Dec. 20; in Gibraltar on Jan. 2. In Cyprus, it began at the two seaports Larnaca and Limassol early in December, and spread thence to remote parts; but only after visits of their inhabitants to infected areas. Horses, mules, and cows were affected. In Jamaica, the disease commenced in camp in the middle of November 1889, after the arrival of an

[1] The great fair of Nijni-Novgorod, attended by immense numbers of people from all parts of Russia, is held in July or August.

officer's wife, who had suffered, from England. The horses were attacked soon after the officers. In New York, the first case noticed by a physician was that of a young German woman, on Dec. 11, who had received a letter from Berlin on Dec. 10. Other cases followed in the same family.

In an able Report by Dr. Ranet, Secretary to the Illinois State Board of Health, he shows that the influenza extended in three months, with a greater rapidity than any of which we have a record, over Europe and a large part of North America. It broke out generally first in large cities, and appeared to follow communications. In 1843 it consumed six months in making its way through the smaller part of North America then inhabited. Guernsey was reached on Jan. 10, 1890; Jersey on Jan. 24; Alderney about Jan. 25 (garrison on 25th). The first two cases in Alderney were the men engaged in taking charge of the parcels brought by steamer. Iceland appears to have been reached about the beginning of July 1890. Previous epidemics there are said to have always occurred in the summer, a fact easily explained by the paucity of communication with the continent during the winter. In Tobago, West Indies, the influenza began at the port of entry. Bermuda escaped influenza, or had it lightly, with the exception of Ireland Island. Here the epidemic broke out on March 27, 1890, on board H.M.S. *Bellerophon*, which had just come into harbour and moored just ahead of the *Saga*, which had suffered very severely from influenza just after starting from Havana, and had only come into harbour (the "Camber") after being granted pratique. Other British vessels moored in the vicinity were subsequently affected until May 22. At Freetown, West Africa, cases occurred about March 3, after the arrival of two vessels with cases on board. At Axim, Gold Coast, one of the first cases (in May) was a custom-house officer, and it was observed to spread among the officials in contact with him. In Natal the disease appeared to be imported by passengers and letters. In Rodriguez, the epidemic began at the end of June 1890, and followed the arrival of H.M.S. *Garnet*, which, however, only remained one day. The *Garnet* had had 50 men out of 235 affected, from March 16 to April 9. The *Maggie Low* arrived on June 17. At Reunion, the influenza was introduced as follows in September—A lady visited a house in Mauritius where it was prevalent; she returned to a house in the country, which was quite free from it, and herself developed symptoms which, two days later, affected the family and servants.

In India the epidemic seemed to depend on military drafts from England, and the movement of troops. In Ceylon the first cases, about Feb. 7, were among boatmen at Colombo, after the arrival of the *Himalaya* with cases on board; and an early case occurred in a post-office sorter. In the up-country places the disease often began among the petty traders at bazaars, and spread to the labourers, etc., who came to make purchases. In Penang it occurred among the coolies who opened cases of "piece goods." In Sydney, the extension of the disease was gradual from towns to country, "not faster than a man could very easily travel." In Africa, and in the remote highlands of the Himalayas, there was clearly no influenza except where it was carried by travellers. The same may be said with regard to all primitive and uncivilized countries, where movement is comparatively slow, and communication rare, so that the gradual extension of the epidemic becomes apparent, and atmospheric precipitation correspondingly incredible.

It is a remarkable circumstance that in some hospitals no patients were attacked, and in others few, although the nurses were subject to influenza. We may attribute this immunity to—1. The cleanliness and good ventilation of the wards. 2. The security from any chill which would predispose. 3. The small number of opportunities for infection.

At Llanfyllin, the first case was that of a governess who had been engaged unpacking parcels of cloth from a London house in which there was much influenza. There are many other cases of this kind which need not be detailed, and some have been recorded in previous epidemics.

It appears that islands quite unvisited by human beings within the period of influenza-prevalence on the continents have been quite free from influenza. Islands seldom visited have either not been attacked at all, or later in proportion to the lateness of human communication.

Light-ships and lighthouses have been free from influenza, except in the very rare case of communication with the shore.

Deep-sea fishermen were free from influenza during their isolation at sea.

Prisons were largely exempt from influenza, and warders or attendants who were not living in the prison were much more subject to attack.

Isolated institutions were not attacked; but others with communications with foreign countries were amongst the earliest to suffer.

Thus we have a large number of persons, amounting to several thousands, who were well isolated, and not one of whom suffered from the disease. This alone seems almost decisive against any theory of common infection by the general atmosphere.

Dr. Parsons sums up to the following purport—That the progress of the epidemic was independent of season or weather; that it did not travel faster than human beings; that it has not occurred among persons placed under circumstances precluding communication by human agency; that it appeared usually first in the capital, ports of entry, or frontier towns; that many instances of introduction and spread in a district are recorded; that persons out-of-doors if brought much into contact with others, as by business in towns, have generally been the first to suffer; that persons employed in large numbers together have suffered most; and he is of opinion that the epidemic has been propagated mainly, if not entirely, by human intercourse, though not in every case necessarily from a person obviously suffering from the disease.

In this volume is published the Report by Dr. Casey, M. O. H. of the New Windsor district. He believes the primary nidus of the disease to be situated in the posterior part of the nares and pharynx, while the main stress of the general illness falls upon the cerebro-spinal nervous system. "Concerning the question of infectiousness, I have no doubt at all. The natural history of the disease resembles that of other infectious (zymotic) diseases. Certainly it most of all resembles a common feverish cold, but that disease also, I am fully convinced, is infectious and zymotic. When one member of a household was attacked, the rest nearly always subsequently suffered. Medical men were affected early, and in proportion beyond the average. Railway-drivers escaped with comparative immunity, as compared with porters." This immunity was probably owing to the outdoor life and freedom from those opportunities of infection which would be frequent in the station and porters' room.

Dr. Barnes, M. O. H. of Eye, says, "it appears to have been wholly introduced by persons conveying it from infected districts, particularly from London. Railway officials at different stations suffered early, so that railways seem to have been one chief channel, at any rate, for the conveyance of the disease." Dr. Dobbs, of Shanklin, says it was "certainly and largely introduced by letters from infected districts and houses. The first case here occurred after the receipt of letters from Vienna by a person who had not herself left Shanklin for three months." In another place (see p. 288, Official Report) in the West of England, the first case was a boy who had come from Eton, from a house where several of the family had been attacked, through the return of one from Germany. At Paignton, the first case noticed was the postmaster, on Dec. 18, 1889; he had that day been sorting an unusually heavy mail from Paris, and had opened one letter himself. In another place, it was brought at the end of December by a young lady who had been at school in Germany. In another, the introduction of influenza to a village was traced to a house where a lady was attacked who had received a letter from her sister at Monte Carlo, where the family of nine persons were down with the disease in forty-eight hours. In another village the first patient had a large London correspondence. In the Blofield district no cases occurred in the workhouse (p. 81), although influenza prevailed in houses close to it. The master exercised care in keeping newly-admitted paupers by themselves for a few days. At Twickenham, Mr. Murphy made a series of valuable observations, showing that the male members of households, being employed in London, were the first attacked; that the period of incubation was on an average about seventy-two hours; that the power of a person to infect another begins with the initial symptoms of chill, pains, etc.; that the contagium is in the breath; that it does not travel far, for when the sick could be persuaded to keep to their rooms, no fresh cases occurred until they got about the house again; that it is not very hard to destroy, for in four houses where the first person sick was isolated, and disinfectants used as if the disease had been measles, it did not affect any others; that it does not apparently infect letters, clothes, or furniture.

The observation of Dr. Graham, of Weybridge, tallies with Mr. Murphy's regarding the successful effect of separation, for he says that "as a rule, when it broke out in a cottage, none of the inmates escaped, which was, I think, quite the exception in large houses."

Dr. Sinclair relates an early case of a child's nurse being attacked in London, Dec. 3, four days after the visit to the nursery of a lady from Paris who had just left her family there ill of "la grippe."

The ways in which infection may be introduced to a village, town, or country are numerous; but probably the vast majority of early cases are due to proximity to persons arrived from infected places. The early outbreaks at Keal and other places in Lincolnshire, in 1889, may have been due to one or several of the following causes—Imported ponies and horses (called Russian) from Hamburg to Grimsby. Russian sailors accompanying imported Russian timber. Emigrants from Russia constantly passing through Hull to Liverpool. Return of a person from London, where illness had apparently been contracted at Barnum's Show; the influenza spread to the village from this case. In the epidemic of 1891, at Hull, which afterwards spread so disastrously over England, the first cases seem to have occurred immediately after the passage through the town of an unusually large number of emigrants from the continent of Europe *en route* for America.[1]

The ordinary intercourse by railway, etc., between town and country, between families in villages, the assemblages in social and political meetings, in church and school, the condition of the air in all places of resort and business, amply suffice to explain the rapid spread of the disease, and the occasional prostration of a large number of inhabitants about the same time. The facts concerning the spread of hospital fever, of diphtheria and other fevers, of small-pox, and the accidental infections, despite precautions, which have occurred in laboratories (see Klein, etc.), prove the potency of a very small modicum of organic dust to propagate certain diseases in previously unaffected or highly susceptible subjects. Pleuro-pneumonia and foot and mouth disease in cattle show a similarly strong infective influence.

But we have very good ground for supposing that, if ordinary precautions were taken, as in measles or scarlet fever, to isolate the influenza patient, and to guard above all against the infection from early cases, and against free introduction and dissemination from

[1] Local Government Board Report, p. 324. Dr. Bruce Low.

foreign countries, influenza would claim very few victims, and anything approaching a national epidemic would become improbable. There is every reason to believe that the cause of the disease is neither in the general atmosphere, nor, to any appreciable extent, in the outdoor air of a town in which influenza prevails. Institutions in the midst of a suffering town, if kept from communications and intercourse, remain exempt. People who went to London during the continuance of the epidemic on the top of an omnibus, or if by train with carriage-windows open, and were not otherwise exposed to infection in rooms, escaped, until perhaps a member of their family was attacked, and then contiguity in the same room was sufficient to determine an attack.

Examples of ships being attacked in mid-ocean have long served to support the belief in atmospheric infection, but on examination these examples lose their value. Communications are found after all to have existed between the ship and the shore, or there is reason to think that influenza, not publicly noticed perhaps, prevailed on shore at the port of embarkation before sailing, or at a place whence some of the sailors may have been drawn. It may be taken as a general rule that influenza exists at a place fully a month before it becomes widely known, or officially notified. Thus the chances are considerable that one or more in the crew of a large ship may bring the elements of an outbreak on board, or that provisions and goods may be opened after many days, diffusing on disturbance the organic dust which in a confined space and bad air will easily infect persons exposed to it.

Dr. Parsons has shown (p. 93, L. G. B. Report) that the cases of outbreak on board the *Goliah* and Lord Howe's squadron in 1782 do not by any means prove infection not to have been conveyed by human intercourse; it was reported that the ships had had "no communication with the shore," but not that there was no communication with any other vessel, or that no despatches had been received. A quotation from Dr. Gregory seems to refer to Lord Howe's fleet, and if so, the "no communication" is incorrect. "The whole fleet was in excellent health and spirits, when a cutter arrived from the Admiralty, and the signal was given for an officer from each ship. An officer was accordingly sent with a boat's crew from every vessel, and returned with orders, carrying with them also, however, the influenza" (*Life of Sir Robert Christison*). This is a very interesting extract; it not only shows the baselessness of a story which has served for a century to prop a calamitous theory, but it shows how a disease like influenza can be carried from one centre by men living in healthy conditions and passing through the open air, to other communities, and how subtle and strong the microbic virus must be to the susceptible.[1] It is a typical case. In the same way, men go to the city on business, are exposed to the breath of an influenza subject in office or stores, or in the stuffy omnibus or railroad-car, and bring back the infection to their family, their village, their country town.

In another often-quoted instance, the *Stag*, Dr. Parsons has discovered that the ship arrived off Berry Head, not "Beachy Head"; that an "easterly wind" would not blow off the land; and that nothing is said as

[1] It is assumed that these men caught the disease, and from themselves, when prostrate, infected their ships.

to any previous communication with the shore, *e.g.* with Plymouth or Falmouth. The case of the ship, on board which influenza broke out between Malacca and Canton, in 1780, is explicable either by the fact of the disease having prevailed about the same time on the coast of Coromandel and in Bengal, whence persons or goods may have come on board, or by previous trading from Canton, where it had raged, to Malacca. In the epidemic of 1889-90, no authentic case has been recorded of any outbreak on board a ship at sea, if at the date of sailing influenza did not already exist on shore.

With regard to the two classes of persons who may be said to be on the whole well-isolated, viz. deep-sea fishermen and the keepers of lightships and rock lighthouses, both these classes appear to have been exempt from the disease, with the exception of a few cases contracted ashore or by communication with other cases. The number of cases which would have occurred proportionately to their number, say one in four, is about 400. The very few cases which occurred among these men followed upon communications with the shore, which were exceptional. A more perfect experimental proof of human as opposed to atmospheric infection it is difficult to imagine.

Upon a review of the evidence we find that the disease is beyond all question communicated by infected persons and things, and that there is no instance of an isolated person contracting influenza; that is, that practically, the general atmosphere does not convey it or ever cause an epidemic over large areas of the surface of the globe.

We may hope that this is the last epidemic or pestilence of any sort attributed to atmospheric agency.

Measures of prevention can hardly be very dissimilar to those employed in other infectious diseases. Not only isolation, but thorough disinfection and airing, especially of clothing, bedding, carpets, and furniture, is called for. Isolation of the early cases, and the promptest action to prevent spread from travellers would probably be successful in depriving the pest of the mass of those who would by the present *laissez-aller régime* be its victims. Many persons have had a second attack of influenza after returning to their homes after months of absence, owing apparently to survival of microbic remnants in the clothes, carpets, etc., previously infected. A sufficient number of instances have occurred, to prove the conveyance of infection in closed parcels; and it is very desirable that goods from infected places should be well aired before use, and indeed that they should be unpacked out-of-doors.

International regulations might be framed which would arrest the progress of influenza from country to country, and internal machinery might be prepared for the confinement of outbreaks to the fewest possible centres. If the provisions (with modifications) put into force for the prevention of the propagation of plague, cholera, diphtheria, and small-pox were used against influenza, it could hardly make its way successfully. The early cases, which are often very slight, would need very careful treatment and diagnosis, and even severe colds or sore throats would be advantageously treated apart during the prevalence of the epidemic abroad. The loss of life by an epidemic of influenza is very great; greater than that caused by the last epidemic of cholera in England; and the money loss to the country amounts to several millions, as indicated by the demands on insurance societies. The expenditure of a few thousand pounds in defensive preparations, when influenza is on the march towards this country, or more accurately, when people are spreading it by their movements from place to place, would, with the assistance of the community, prevent any attack in force, or epidemic diffusion. The regulation of port sanitary authorities in relation to cholera, yellow fever, and small-pox, already serve as a model from which regulations for the defence of the whole country against epidemics in general may be safely drawn.

The behaviour of influenza introduced into a community is "capricious," and gives much reason for hope that the difficulties of suppressing it are not insuperable. In many cases it did not spread from a first subject; it seems to be much more infectious in some forms and in some people than in others; and moreover, it will not spread easily except where human material is fitly laid, as from a first subject to highly susceptible persons, from these to less susceptible, and from these to the more refractory. Thus the most favourable conditions for its "burning up," as it were, are the congregation of a variety of individuals in one badly-ventilated building, where it can choose its appropriate victims, and the presence in this assemblage of a subject in that stage of the disease when most virulent organisms emanate from his body.

The immunity conferred by a first attack appears to hold for a short period both for individuals and communities; but there are many exceptions, and the predisposed are easily attacked a second time. The strong mild winds of January 1890, by increasing ventilation in houses, railway-carriages, omnibuses, and public buildings, and by removing the germs from clothes, etc., seem to have saved a large number of persons from attack, and many of these subsequently fell victims in the more fatal epidemic of 1891. These winds came at a time when most of the highly-susceptible persons had already suffered, and therefore the materials for an easy recrudescence or conflagration were removed. After more than a year's interval, many of the susceptible were again assailable, and many persons who had not been fit subjects had become so, for the same person may be variably susceptible, and escape after a first exposure by no means guarantees against the effects of a second, as was shown in many cases of medical patients.

The difference in the rate of propagation of influenza, and in its effects on different persons exposed to it, gives the strongest ground for a belief in the power of isolation and disinfection of early cases to prevent its wide diffusion. The most important point to be borne in mind is the early detachment of first cases, so that not many persons should be exposed to sources of infection. Consequently notification should be required as a first necessity, and attendance of its subjects at assemblies, social gatherings, alehouses, etc., should be prohibited. The fee for notification in the case of influenza might be abolished, or paid from national funds.

All persons arriving from infected countries should receive notice on landing to report themselves to the Local Medical Officer of Health of any place in which they may be living during the next fourteen days.

The diffusion of influenza germs in letters and packets arriving from infected countries through the post is not easily dealt with. But a general recognition of the necessity of care in the opening and handling of suspected materials would largely diminish the frequency of the cases thus arising. Envelopes should not be gummed by patients, and in times of epidemic should be opened at the edges by the recipient; letters might be heated before despatch.

Note.—Since the above article was printed, the influenza microbe has been discovered in Berlin, and investigated by Messrs. Pfeiffer, Canon, and Kitasato. It is extremely minute, visible only with difficulty, and exists in immense numbers in the blood and sputa of patients.

Messrs. Cornil and Chantemesse have made experiments on animals, which confirm the discovery, and considered that their observations tended to show that the influenza is an infectious disease caused by a bacterium.

Bareggi, on Dec. 17, 1891, had already discovered bacilli like those described by Pfeiffer. He found the microbe afterwards in a series of cases of pneumonia and bronchitis following influenza, in the sputa. These observations show how infection from supposed cases of "bronchitis" after an influenza epidemic may be explained.

Bruschettini also confirms Canon's observations. The microbes from the blood grew luxuriantly in artificial nutrient media.

For further and valuable information in relation to the suppression of influenza, Dr. Sisley's recent volume and papers on the subject may be consulted.

MALARIA.

Malaria is generated in marshes containing a high percentage of organic matter.[1] In sandy soils and arid-looking plains devoid of vegetation, malaria is also sometimes found, but in such cases the soil contains a considerable proportion of organic matter, and water not far from the surface, either in the shape of subterraneous streams, or detained by a bed of clay below the sand, stagnating and prevented from evaporating. Rocks, as granite or trap, also produce it. At Hong Kong, when extensive excavations were made in disintegrated granite, violent and fatal remittent fevers appeared. We may, however, take leave to doubt the directness of this result, and rather to ascribe it to some coincident disturbance and pollution of water, or to the improper disposal of refuse. Disintegrated granite is highly absorbent of water, and often becomes permeated by a fungus (Friedel). Malaria abounds in low jungly districts during and after the rains, at the bases of great mountain ranges, and in belts of country rich in organic matter. It can drift along plains for some moderate distance without losing its harmful properties, and occasionally ascends mountains, especially by ravines. It does not, however, seem to prevail in general above 2000 feet. It is apparently often imbibed in drinking-water. Sheets of water and belts

[1] Reynolds' *Medicine*. Article "Malaria," by Maclean.

of trees interposed between habitations and the source of malaria act as defences. Malaria disappears with cultivation and subsoil drainage, and resumes its sway on their discontinuance. Malaria, which includes ague, remittent and intermittent fever, is also connected in its habitat and causation with dysentery and cholera. A first attack of ague takes the quotidian, or more severe form. When a person has long suffered from malaria, a curious periodicity shows itself in all his subsequent ailments.

According to Parkes,[1] the soils with the worst malarial exhalations are—(1) Old estuaries, alluvial soils, and deltas. Peat is less favourable to malaria. Marshes overflowed regularly by the sea are often healthy, while the occasional mixture of salt water increases the emanations. (2) Sands, if there is an impermeable clay or marly subsoil. Old watercourses are also malarious. (3) The lower parts of the chalk where there is a subsoil of gault or clay. (4) Weathered granitic or trap rocks, if vegetable matter is intermixed. (5) Rich vegetable soils at the foot of hills.

Malaria may cause great destruction on dry plains, as when the British army suffered in Estramadura, and in the approach towards Ciudad Rodrigo, when the whole country was burnt up so as to resemble a brick-ground. But both of these districts are under water in the rainy season. The disease may sometimes be caught when passing through unhealthy regions, without showing much constitutional disturbance until after many days, perhaps after reaching another climate, when, either owing to fatigue, depression, or other influences, it breaks out with severe fever. The remains of

[1] Quain's Dictionary.

malaria are difficult to extirpate altogether, and the fever is apt to break out again when the subject of it catches cold or loses tone. It seems as if the organism were still located in some part of the body, and were only prevented from thriving permanently in the body by having to some extent exhausted the particular matter in the blood upon which it feeds, and by the activity of healthy blood, which keeps it down to a minimum. The assailant, kept in duress within the body, is enabled to sally forth and multiply when the blood becomes by any cause enfeebled and ill-nourished. And its own pabulum is in this condition probably more abundant, if it consist of excretory matter not duly eliminated by the skin, etc., as would happen in case of a chill or gastric disorder.

The malaria from the marshes of Brouage is carried as far as Rochefort, seven or eight kilometres distant[1] (about five miles). Marennes is attacked when the wind blows from marshes near it, but not otherwise (Mèlier). The distance to which malaria is borne seldom exceeds one or two miles, except with strong winds (Parkes). Salt water stops the spread of the miasma better than fresh, usually within one mile. According to M. Pluvis, if ponds or marshes occupy one-two-hundredth of a certain district, malaria may affect one-thirteenth of the area. Peat-bogs do not produce marsh fevers and agues. Malaria does not usually exist at a height greater than 2000 or 3000 feet (Carrière), or 2800 according to Humboldt from observation in Mexico.

In marshy, malarious countries cattle may be much affected and die out. In Sologne the land has been

[1] *Dictionary of Hygiene.* Tardieu and Blyth, 1876.

reclaimed by canal irrigation, lining the earth with chalk, and planting woods.

Klebs and Tommasi-Crudeli described a bacillus occurring in the soil of the Roman Campagna, which they cultivated on gelatine.[1] The bacillus is about 0·002 to 0·007 mm. long, multiplies by spore formation, and grows well in albumen, glue, etc. Marchiafava and Celli found that malaria blood containing certain bodies, in size a fraction of that of the blood-discs, is capable of producing intermittent fever in man after intravenous injection.

Malaria, ague, or intermittent fever is associated with exposure to exhalations from marshy ground.[2] Klebs and Tommasi-Crudeli discovered that by treating with water the soil of a fever-haunted marsh, the germs of an organism could be washed out; that this organism floated in the air which rested on the marsh; that by shaking up this air with water they might be washed out from the air; and that water thus infected when introduced into the circulation of a dog produced ague more or less rapidly, according to the numbers in which the microbes were present. These bacilli were found in the Campagna and Pontine marshes, but not in healthy places in Lombardy.[3] In the human subject the bacilli disappear at the acme of the fever, and spores appear. Others found the bacilli in the blood in the cold stage, and only spores in the hot stage. The intermittent character of marsh fever has been attributed to the increased activity of the bacillus before

[1] *Micro-organisms and Disease.* Klein.

[2] Transactions of the Social Science Association. Address by Sir C. Cameron, M.D., M.P.

[3] See also *Climate and Fevers of India.* Fayrer.

it emits spores, every forty-eight or seventy-two hours, etc.

The hæmatozoon described by Laveran in 1880, has since that date been recognized by many other observers, and is supposed to be the organism actually concerned in the production of malaria.[1] The organisms vary in form; there are spherical bodies with amœboid movements; there are flagella, cruciform, and rosette-shaped bodies. The blood in paludism is easily studied by rapid drying and fixation of the specimen by heat. Similar hæmatozoa have been found in frogs, lizards, marsh tortoises, and birds.

It may be mentioned here that *relapsing fever* is caused by an organism named *Spirochaete obermeieri*, which appears in very great numbers in the blood during the access of the fever.[2]

The special danger of the sunset hour may be owing to the concurrence of these three circumstances—the concentration of microbes or spores at a level a little above the ground; the dew condensing upon them preserving their virulence; and the rapid cooling of the human skin driving the blood towards the inner surfaces, *e.g.* the mucous membrane of the throat, where any congestion would favour the inoculation of germs drawn in with the breath. Any one who observes the behaviour of dust stirred up by carriages on dusty roads, will not fail to note the difference between the dispersion and wafting away which occurs in the daytime, and the settlement in a thick horizontal layer which distinguishes the evening of a warm summer day. There is no lifting by ascending air-currents, but

[1] International Congress of Hygiene, 1891.

[2] Magnin and Sternberg. *Bacteria.*

apparently a sort of beating-down to a low level and viscous coherence, which is probably caused by the horizontal arrangement of the air near the ground as the earth cools by radiation, and by the instant deposition of vapour on the dust particles. Thus over a dried-up marsh there would be a very great condensation of microbes or spores, which could no longer be dispersed, and they would gather in multitudes about the height of a man's head, as we see a ground-fog form when the air is still and humid after a warm day in autumn. The organisms which were given off while the surface of the ground was warm thus accumulate a little above it as radiation rapidly carries off the heat and cools down the lowest stratum of air. About sunset the earth is still warm, and exhales moisture into the rapidly cooling air immediately above it, and with earth vapour earth organisms are largely given off. The human body is then most susceptible to their action, and the congested interior surfaces give a breeding-ground to the parasite. Later on in the night the organisms have largely sunk, by their own gravitation and the extra weighting of deposited dew, on to the ground, and moreover the body is not so much open to attack of the microbes remaining suspended in the air. Many of the known microbic germs are incapable of maintaining their virulence or their life in dry air, and so the malarious microbes have the heyday of their strength in the sunset hour, when the air is saturated near the surface and dew deposited upon themselves, before either they or the dew can be largely condensed upon the ground. Malaria does not as a rule attack persons in a room with a good fire, where the air is dry, or in an upper chamber with the windows closed at night.

Laveran found a bacillus in intermittent fever in Algeria, and says it embeds itself in the red corpuscle.[1] He found it in patients at Rome, and in a sailor just returned from China with intermittent fever. The organisms were at their maximum at the beginning of the rise of temperature, and later the high temperature of the blood killed (?) them. With a chill, a fresh development was noted.

After a terrible flood in Bengal, says Pritchard,[2] "the waters subsided to give birth to a malarious fever that raged over the recently inundated area, and swept away thousands of victims."

The practice of sleeping on a ground-floor in a tropical climate is well known to invite the influence of malaria.[3]

Famine is invariably followed by epidemic disease, fever, or cholera.[4] Diarrhœa and pestilence followed the Orissa famine, when half the district of Cuttack, 1500 square miles, had been flooded.[5]

The highly dangerous and fatal fever of Bhotan[6] appears to be malarious in character. Bhotan lies between Bengal and Assam, with Thibet on the north. The habits of the Bhotanese are excessively filthy. Some of their forts were found wholly covered with eighteen inches of filth, and any disturbance of this filth was disastrous. Vegetable food was scarce, and the men suffered from ague, fever, and scurvy.

A hundred years ago scurvy, dysentery, and malarious fevers prevailed in England, and jail fever was epidemic.[7] The ships of the Navy were homes of pestilence. The

1 Trouessart on Microbes, etc., p. 184.

2 *Administration in India*, p. 89.

3 *Ibid.* p. 184. 4 *Ibid.* p. 239. 5 *Ibid.* p. 272.

6 *Ibid.* p. 2, vol. ii. 7 *Ibid.* p. 276.

health of the army of the Crimea, which suffered very severely, was restored by sanitary measures. By sanitary measures the health of the troops in the China war, and in the Canadian and Abyssinian campaigns was preserved as never before.

Fever occurs by the banks of the Hooghly and in Serohee and Marwar after heavy rains.[1]

The Army Sanitary Commission of India pointed out in 1872 the conditions under which the very severe and disastrous malarial fever of Burdwan[2] prevailed, a fever which had in previous years been reported on. In June 1862, the chief magistrate of Burdwan wrote—"It is no exaggeration to say that at that time (September, 1861) almost every human being resident in the town was more or less affected by fever. The whole of South Burdwan presented one uniform and lamentable scene; with some few exceptions whole villages were utterly prostrated, and suffering from the debilitating effects of fever." The population of the town of Burdwan declined from 46,121 to 32,687. The Commission reported that the fevers "must either be left to cut off all the predisposed, leaving the remainder more or less unfit to gain their living, and to become fit subjects for the next increase or outbreak of the fever; or means must be taken to drain the country, improve its agriculture, and introduce sanitary improvements in villages." Dr. Payne says that though the ground appears to be dry, the water really lies within one foot of the surface in a stagnant condition.

In a pamphlet entitled, "Observation on the Causes

[1] *Administration in India*, p. 338. Pritchard.

[2] Report of Measures adopted for Sanitary Improvements in India. Blue-book, 1873, pp. 11, 12, 13, 14, 230.

and Prevention of Fever and other Epidemics in India," Syed Abdoolah describes the ordinary native dwellings in Indian towns, the badly ventilated and lighted yards and rooms, and absolute absence of drainage, the foul waste water of houses either discharged into a side gutter and then allowed to evaporate, or, where no such gutter exists, discharged into an earthen jar sunk at the side of the lane or street and occasionally emptied on the nearest dunghill. Sometimes a hole dug at the side of the street is the receptacle of liquid refuse, while the contents of the masonry cesspools in the more wealthy native houses are, when full, thrown out indiscriminately over the thoroughfares to be absorbed or to evaporate. The nature and management of the water-supply is moreover a lamentably active cause of disease all over India.

The Army Sanitary Commission states[1] that "every death represents perhaps forty or fifty cases of fever, and every attack of fever lowers the stamina and working ability of the sufferers, and so tends to impoverish the country." Improved agriculture and drainage is suggested as a remedy.

Mr. Planck, in a Report[2] on the N. W. Provinces for 1871, states in regard to one district, that the state of surface moisture alone would suffice to make fever a prevalent complaint; that high death-rates exist where there is no irrigation; but that undue application of water to moist subsoils gives rise to spleen disease among the population.

There is already Indian experience to show[3] that

[1] Report of Measures adopted for Sanitary Improvements in India. Blue-book, 1873, p. 36.

[2] *Ibid.* p. 221. [3] *Ibid.* p. 222.

what amounts to very marked improvement in the public health of villages can be effected by very simple means, such as rigid attention to cleanliness in streets, compounds, and houses, including the removal of all noxious matters to a safe distance, improving the surface drainage of streets, filling up holes, raising the tubes of wells above ground, and protecting the water from pollution, etc. Spade labour and cleansing would do most of what is required for small groups of population.

In a Memorandum on the Sanitary Report for the Province of Oudh in 1871, the Commission observes that the country appears to be mainly low and flat with reference to rivers and natural drainage outfalls, and that the level of subsoil water rises considerably after rain. Parts of the country are liable to floods, which pollute the wells, and in these districts fever is very prevalent and fatal. Frequently it breaks out on the subsidence of the floods. The mortality from cholera during 1871 was 15,832, but the deaths from fever were more than eight times as many.

In the Report on the Punjaub for 1871, it appears[1] that spleen disease and fever attain the highest percentage on the irrigated low land in the north of the Doab, and the lowest in the high, sandy, well-irrigated country towards the Bias; or, speaking generally, it is highest where the water-level is nearest, and lowest where it is farthest from the surface, while between these extremes the parallelism is also pretty generally retained. It follows that improving the drainages of a district is an essential part of irrigation work. Dr. Taylor says, "the effect produced on the health of the

[1] Report of Measures adopted for Sanitary Improvements in India. Blue-book, 1873, p. 228.

population of the villages of Najaggarh jhils by the enlargement and improvement of the drainage cut to the Jumna in 1857 has been extraordinary. Splenic enlargement cases fell from 43 per cent. in 1845 to 5·37 per cent. in 1867-8. The average flood-level is reduced three feet, and the aspect of the people is healthy and robust. The Commission observe that the experience of irrigation works in India has shown that a high subsoil water-level is incompatible with the health of the cultivators. Irrigation water should be kept in movement. This experience throws a flood of light on the causes of malarial fever all over India.

The incidence of disease at Bangalore is instructive, for in spite of its excellent situation, diarrhœa, dysentery, and malarious fevers are endemic. Mr. Nicholson points out (1871) that though the surface of the ground is kept fairly clean, the subsoil and its water is becoming progressively poisoned by filthy deposits and infiltrations from cesspools. The contaminated water is in use for drinking. "Cesspits and wells should never be formed together in a porous soil." Impurities spread laterally over a considerable area, and gain admission to tanks by infiltration as well as by surface washings. Drainage and good water-supply are the remedies recommended.

In a Report on the Native Army of Madras for 1870, it is stated[1] that the huts in use could apparently be made more healthy by raising the floor above the ground-level, and draining away stagnant water in their vicinity.

The following causes of malarious fever at a variety of places are mentioned in the Summary of Sanitary

[1] Report of Measures adopted for Sanitary Improvements in India. Blue-book, 1873, p. 249.

Sheets for Native Corps in the Provinces of Bombay, Madras, and Bengal [1]—

"Immediate outskirts of station very swampy and feverish.

"Exposure in jungles in Assam.

"Active service in the rainy season, imperfect diet, doubtful water, and deficient bedding.

"Vicinity of the marsh, about half a mile from the lines.

"Afghan campaign had a bad effect on the health of the men.

"Exposure on service.

"Hardships on active service.

"Men somewhat debilitated by last year's active service, and more susceptible to disease.

"Exposure on field service, bad water on return march.

"Intermittent fevers caused by fatigue and exposure.

"Floors of huts below ground-level. Ventilation defective. Duty always heavy. Soil retentive of moisture. Water-supply liable to contamination. Malaria caused by long open drains, and by the practice of flooding compounds under the hot sun.

"Lying in open air without sufficient warm clothing caused malaria.

"Bad drainage, low position of lines, soakage into soil. Bad water."

Jails. "Sickness partly attributed to the wide-spread fever epidemic, caused by the drying of the waters after the flood of 1879.

"Ventilation and drainage imperfect. Overcrowding. Water polluted with recent organic matter. Forced labour. Sleeping very near the ground.

"Fevers are very prevalent during and after the rains.

[1] Eighteenth Annual Report of the Sanitary Commissioner with the Government of India, 1882, p. 72.

"Excessive fever due to heavy rainfall and to water lodging in the ditch surrounding the sleeping barracks.

"All the earth inside the jail area was dug out to a depth of one foot and thrown away, and replaced by a thin layer of fresh dry earth. In this way a large quantity of decaying organic matter (which had a good deal to do with the causation of dysentery and diarrhœa, as well as of intractable ulcers) was got rid of."

The Commission observe,[1] with regard to the great mortality from fever in the Nuddea district of Bengal, that one of the ways in which water is polluted is by the bodies of the dead being thrown into the river instead of being burned.

With regard to the very severe outbreak of fever in Amritsar, they note that the worst ravages were among the badly-fed, poor, and badly-clad Kashmiris, and that two-thirds of the infantile population died, the health of the remainder being shattered. It would appear that not a single European or native escaped an attack. Saturation of soil, and imperfect drainage and conservancy appear to have been the chief contributors to the epidemic.

The Reports from Bengal cantonments contained the following remarks [2]—

"Intermittent fever due to dampness and the drying of the surrounding swampy lands.

"Malarious fever due to imperfect drainage and lodgment of subsoil water.

"Malarious fever due to the neighbourhood of the fort being inundated during the rains, to the swampy state of ground, etc.

[1] Eighteenth Annual Report of the Sanitary Commissioner with the Government of India, 1882, p. 137.

[2] *Ibid.* p. 159.

"Malarious fever due to the presence of marshes in the vicinity of the cantonments."

These are merely specimens of reports, which mostly tell the same tale of floods, or damp ground, defective drainage, bad water, improper food, overcrowding, deficient clothing, and overwork, as exciting causes.

Dr. Morton, before leaving Peshawur, addressed a letter,[1] dated November 14, 1871, to the Sanitary Commission, desiring to "take the last opportunity of again bringing to your notice the terrible condition of the water-supply for the Peshawur city and cantonments. . . . No language could well be too strong in describing the abominations of the whole existing arrangements. . . . Of course the grave and radical defect is the open main channel, exposed to every species of contamination. . . Then the stream which chiefly supplies the Sudder Bazar passes by the cesspools, . . . literally within one yard of cesspools now in actual use. . . The deeper channel I have spoken of is actually on a lower level than the ordure of the pits. . . . The effect on the unhappy dhooly-bearers may be learnt from the records at the station hospital, where in 1870 these poor creatures died like rotten sheep. . . . In conclusion, I can only say that I do not see how matters could be worse except in a community which drew no distinction whatever between its cesspools and water-tanks, and used each indiscriminately for all purposes." No wonder that Peshawur was once known as the graveyard of India!

The Commission note[2] that Dr. Payne has again called attention to the fatal results of allowing the natural

[1] Report of Measures adopted for Sanitary Improvements in India, 1871-72. Blue-book, p. 20.

[2] *Ibid.* p. 214.

drainage of a country like Lower Bengal to become obstructed. Referring to a previous opinion on the subject expressed by Dr. Smith, the Sanitary Commissioner of Bengal, he says this view is one which he ventures to think the events of each succeeding year tend more and more to bring into absolute demonstration, viz. the gradual conversion of a well-drained, healthy, prosperous tract of country into the condition of the Lincolnshire Fens of many years ago, with a subsoil water-logged and exhaling marsh poisons for the population to absorb.

With regard to the Burdwan fever, Dr. Elliot stated "that a very large proportion of the people were suffering from the usual sequelæ, which are perhaps more harassing than the disease itself. Enlargment of the liver and spleen, dysentery, diarrhœa, and œdema of the legs and feet are most frequently met with. In most of such cases the fatal result is only a matter of time."

The causes of this fever were given in a Memorandum of the Commission in 1870, as follows—"Lowness of situation, want of drainage, filling up of natural water-courses and obstruction, unhealthy expanses of shallow water, occasional flooding, marsh-ground, water-logged subsoil, unwholesome nullahs, and the like."

Referring to tables of prison sickness and mortality, Dr. Cornish sums up the results already obtained as follows [1]—"We here see in the space of ten years that the hospital admissions have been reduced by more than one-half, and the mortality by nearly three-fourths, and both of these proportions probably are capable of even still further reduction." This improvement was brought

[1] Report of Measures adopted for Sanitary Improvements in India, 1871-72. Blue-book, p. 217.

about by the abandonment of unhealthy buildings and localities, better jail construction, various sanitary measures, better dietary, diminution of overcrowding, etc.

The Sanitary Commissioner with the Government of India, in his Review of Sanitary Reports, finds[1] that the fever is more persistent in its prevalence, more virulent, and therefore more fatal in its results in the canal-irrigated country than in the country not irrigated by the canal, unless this should be naturally a very moist country. "Indeed, nothing can be more marked as a rule than the difference in the aspect of the people as seen at these inspections, who live where the well-water is found at more than 30 feet from the surface, and where it is found at less than 15 feet." "For eight months of the year, when all the country is dry, away from the canal-irrigated or moist Terai countries, it is unusual to find a case of ague in any village; for four months of the year, when all the land and air is moist, it is difficult to find any village in which persons are not suffering from ague, and this suffering is more general, more lasting and fatal, as the rainfall of any year is greater or late, so that its drying up is delayed."

Dr. Townsend finds in the Central Provinces that the increase of the disease does not depend on any changes in the temperature and moisture of the air. "Ague is most rife when the rains are ceasing or have ceased, when the subsoil water is at its highest level, and without receiving any further addition from rainfall, is retained at a high level by percolation downwards from the more superficial strata, and when the streams and nalas, no longer swollen and flushed by the

[1] Report of Measures adopted for Sanitary Improvements in India, 1871-72. Blue-book, p. 241.

superfluous rainfall, are fed only by percolation through the soil and subsoil." The opinion long entertained that water may dissolve the miasmatic poison, and thereby cause fever, receives support from his investigations. "It is in this way that the populations living on rocky plateaus so often suffer severely, for their water-supply is generally drawn from the low ground, where it is subject to all conditions of contamination through the soil."

African fever, which is malaria, prevails over the whole east and west coasts within the tropical limit, along all the river-courses, on the shores of the inland lakes, and in all low-lying and marshy districts.[1] The higher plateaux are comparatively free from it; but in order to reach these, malarious districts of greater or smaller area have to be traversed. There the system becomes saturated with the fever-germs, which often develop long after the fever region has been left behind. The fever is connected with drying-up water and decaying vegetation. Natives suffer as well as Europeans, particularly in changing from one district to another.[2]

Mr. Baikie states[2] that in connection with remittent fever on the African coast, perfect security is afforded to sleepers by wire-gauze or even mosquito-curtains.

Where there are no marshes there is no fever. The average incubation of malaria extends to nine, twelve, or fourteen days. Dr. Livingstone found that neither he nor any of his party was ill with fever in the desert, but only when they came to the vicinity of lakes and rivers. Dr. Watson says, that near Ciudad Rodrigo

[1] *Tropical Africa,* p. 43. Professor H. Drummond.

[2] *Epidemics,* Craig. *Trans. Sanit. Inst.,* p. 94.

there is a large, bare, open, hollow country, like the dried-up bottom of an extensive lake, and upon more than one occasion, after having been flooded in the rainy season, and become as dry as a brick-ground, there arose to our troops fevers, which, for malignity of type, could only be matched by those on the Guadiana. The same observer mentions, that the crews of ships, though close to the shore, were free from fever, while those who landed were attacked.[1] Among many similar instances, the immunity of a ship close to Walcheren, in 1747, may be mentioned (see *Medico-Chirurgical Review* for 1828). The day-time as a rule is safe, and the night dangerous.

Moisture in the soil is essential for the production of malaria, while clayey, loamy, and marshy soils favour its development.[2] In marshy districts the larger the amount of organic matter present in the soil, the greater will be the prevalence of malaria. There is little doubt that the microbe finds an entrance into the system by means of air, potable water, and food.

Certain districts in Italy are well known to be desolated by malarial fever, such as the Pontine Marshes, the Campagna, and the low plains and valleys of the Po and its tributaries.[3] Many smaller areas are equally dangerous in summer and autumn. The lake of Bolsena, near Orvieto, about twenty-seven miles in circuit, "conceals malaria in the most fatal forms, and the shores, although there are no traces of a marsh, are completely deserted, except where a few sickly hamlets are scattered on their western slopes. The ground is cultivated in

[1] *Epidemics*, Craig. *Trans. Sanit. Inst.*

[2] *Micro-organisms*, Griffiths.

[3] Murray's *Handbook to Central Italy and Rome*, 1850.

many parts down to the water's edge, but the labourers dare not sleep for a single night on the plains where they work by day, and the vast tract of beautiful and productive country, presenting no appreciable condition of soil to account for the existence of malaria, is reduced to a perfect solitude by this invisible calamity."

The tract of country between the Elburz mountains and the Caspian Sea is exposed to deadly fevers. It is swampy, and mostly covered with dense forest.[1]

That part of Kent known as Romney Marsh, and the low flat land in the lower valley of the Medway, and parts of the marshy forest of Sussex, were subject to ague and low fever.[2] The land is rich in these parts, and the people were said to find wealth without health, while on the high ground health without wealth was the rule.

Algeria, perhaps, offers some of the best illustrations of the manner in which engineering operations have remedied the evils of the proximity of marshes.[3] Boná stands on a hill overlooking the sea; a plain of a deep rich vegetable soil extends southward from it, but little raised above the sea-level. The plain receives not only the rainfall which falls on its surface, but the water from adjacent mountains, and is consequently saturated. The population living on and near it suffered intensely from fever; entire regiments were destroyed by death and inefficiency. It was at last determined to drain the plain. The result of this was an immediate reduction of the sick and death-rate. Such instances might be multiplied. Violent outbreaks of fever follow the

[1] *Compendium of Geography and Travel.*

[2] Murray's *Guide to Kent and Sussex.* 1852.

[3] *Healthy Dwellings,* Douglas Galton.

obstruction of the drains of unhealthy plains like that of Boná, that on clearing them the locality again becomes healthy.

Irrigation, if applied in excess, is unhealthy, and should not be allowed near habitations. In Northern Italy, irrigated rice-grounds are not allowed within 1000 yards of small towns.

Fondouc, in Algeria, is situated on sloping ground, immediately above a marshy plain, and has mountain ranges behind it. During twenty years the mortality was 100 per 1000, but since the cultivation of upwards of 10 square miles round the town, the mortality has fallen to twenty.

In India, wherever water is applied in excess for irrigation, so as to become stagnated in the subsoil, ague, spleen disease, and fever prevail.

"The low-lying jungle land, where the subsoil-water is near the surface, . . . abounds in malaria, as is the case with the alluvial basins, silted-up beds and debouchures of rivers, water-logged soil of land in which watercourses have been obstructed, littoral plains, and in some regions, sandy deserts.[1] There are regions, formerly populous, give up to malaria. Malaria seems to be intimately connected in etiology with cholera, dysentery, hepatic disease, bowel-complaints, and other morbid conditions.

Parkes mentions several places in India and Europe where ague ceased after the construction of good wells.[2]

According to Parkes,[3] low elevations of 200 to 300 feet above a malarious surface are often more dangerous

[1] *Climate and Fevers of India,* Fayrer.

[2] *Administration of India,* p. 339. Pritchard.

[3] *Practical Hygiene,* pp. 100 and 472.

than lower lands, and the head of a ravine up which the wind blows from a marsh is far from safe. Apart from the existence of marshes at high elevations, it appears that an upland of 1000 or 1200 feet above the plain is usually healthy; but much depends on the locality. The distance to which malaria spreads laterally seldom exceeds one or two miles, unless the wind is blowing strongly from the malarious surface. In the Channel, 3000 feet of water was sufficient to stop it. In China, three-quarters of a mile, and in the W. Indies one mile, has been effectual.

Organic matter exists in considerable quantities in the air of marshes. Besides this organic matter, various vegetable matters and organisms, floating in the air, are arrested when the air of marshes is drawn through water or sulphuric acid, and débris of plants, infusoria, insects, and even, it is said, small crustacea are found; "the ascensional force given by the evaporation of water seems to be sufficient to lift comparatively large animals into the air."

In the atmosphere generally, the germs of bacterium termo are in great abundance; those of the mycoderms, mucidines, and torulæ are also very common.

The air of marshes appears to be the cause of other diseases besides malaria, probably of a form of diarrhœa, of bloody dysentery, liver abscess, an imperfect condition of nutrition, and enlarged spleen.[1]

Darwin relates that on the whole coast of Peru, but not in the interior, both natives and foreigners suffer in all seasons from severe attacks of ague.[2] The attacks of illness which arise from miasma never fail to appear

[1] *Practical Hygiene*, p. 115.

[2] *Naturalist's Voyage*, p. 365.

most mysterious. The aspect of the country is so favourable that this coast might have been chosen for health. The plain around the outskirts of Callao is sparingly covered with coarse grass, and in some parts there are a few stagnant, though very small, pools of water. The miasma, in all probability, arises from these; for the town of Arica was similarly placed, and its health was much improved by the drainage of some little pools. Luxuriant vegetation and a hot climate do not always produce malaria, for many parts of Brazil, even where there are marshes, are much more healthy than this sterile coast. The island of St. Jago at the Cape de Verds is another instance of an apparently healthy country being very much the contrary. The bare and open plains support a thin vegetation for a few weeks after the rainy season; when this dries up, the air appears to become quite poisonous, both natives and foreigners being often affected with violent fevers. On the other hand, the Galapagos, with a very similar soil, etc., are perfectly healthy. Humboldt has observed that "in the torrid zone the smallest marshes are the most dangerous, being surrounded—as at Vera Cruz and Carthagena—with an arid and sandy soil, which raises the temperature of the ambient air." This is a pointed observation, and we may understand that small pools or the edges of marshes or sandy tracks which have been recently inundated are much more likely to attain a temperature approaching that of the human blood than larger tracts of marsh or water.

In all unhealthy countries, says Darwin, the greatest risk is run by sleeping on shore. Those who stay the night on board a vessel, though anchored only a short distance from the coast, generally suffer less than those actually on shore. Yet there are instances of vessels a long way out from the coast of Africa being attacked by fever during some of the worst periods of death at Sierra Leone.

Darwin, a little further on, describes Callao as a filthy, ill-built seaport, the atmosphere loaded with foul smells, the people drunken and depraved. This may account for some part of the fever of the district, but the general unhealthiness is probably owing to the underground waters becoming stagnant near the coast, having descended from the higher slopes of the Andes, and percolating slowly into the brackish subsoil of the plain. Dr. Ferguson [1] has shown that the poison is generated in the drying process; hence dry, hot countries are often unhealthy after rain.

The manner in which dust, and particles of an organic nature, may be conveyed long distances by the wind, is well illustrated by Darwin's remarks on the fine dust which falls during the prevalence of the harmattan wind on the island of St. Jago (Cape de Verds), and often several hundred miles further out from the African coast.[2] It has fallen more than 1000 miles from the coast of Africa. It obscures the atmosphere, and often dirties everything on board ship. It consists in part of infusoria with siliceous shields and of the siliceous tissues of plants. Darwin himself collected on a vessel 300 miles from land particles of stone above the $\frac{1}{1000}$th of an inch square, mixed with finer matter. "After this fact one need not be surprised at the diffu-

[1] *Trans. Royal Society, Edinburgh.* Vol. ix.

[2] The existence of malaria at St. Jago may be explained by the *Leste,* or strong winds having borne the live germ, on some occasion, with African dust, or by conveyance by human agency, as at Mauritius. In the Galapagos these factors may have been absent.

sion of the far lighter and smaller sporules of cryptogamic plants." And transplantation to a new distant habitat may sometimes occur with the spores of those diseases which can resist the exposure to light and oxygen. Malaria clearly is one which can bear the transport of at least a few miles; germs of diphtheria and small-pox are also probably air-borne in some cases to fresh soil, where they multiply again sufficiently to cause an outbreak in the human body.

Although the coast of Peru appeared dry, as Darwin has narrated, the fact of the constant prevalence of malaria almost proves the existence of much moisture in the soil at a little depth; and this moisture being stagnant, or only gradually drawn up to an arid surface, probably presents a favourable cultivation medium for organisms which thrive on a particular soil in a particular state. Darwin's close observation of certain facts in the geology of the coast further south, affords a clue to the existence of malaria in the plains near the shore. The coast has been raised in the northern part of Chili "at least from 400 to 500, and in some parts from 1000 to 3000 feet, since the epoch of existing shells." "At Valparaiso, within the last 220 years, the rise has been somewhat less than 19 feet; at Lima, a sea-beach has certainly been upheaved from 80 to 90 feet within the Indio-human period.

Lima, the capital of Peru, is in the Bay of Callao, where Darwin's observations on the prevalence of malaria were made. The water in wells at some places in Chili mentioned by him was brackish, and a large quantity of salt still remains in the soil, the rainfall being almost *nil*. A similar condition in the much hotter climate of Peru may be favourable to the organism of malaria. The moisture of the soil is derived from stagnant water underground, and not from rainfall on the coast, and this water must ooze through saline earth full of the organic remains of its former condition as a sea-beach or ocean bed.

In Brazil a violent epidemy is related by Fleming[1] as having followed a long drought, which transformed the Bay of Rio and the low-lying swamps into immense marshes. Here the drying of soil permeated by brackish water, seems to have been the condition favouring the development of the malarial microbe on an immense scale.

In South Africa the immunity level of malaria is about 4000 feet. In Bechuanaland it has been found that irrigation is apt to breed fever in the valleys, and the gardens are kept at a distance from the houses.[2] The fever is not limited to the oozy, jungly, saline marshes north of Delagoa Bay, but is found too in arid tracts where the rainfall is slight; there may be in these places a damp subsoil without drainage; the turning up of such soil produces outbreaks of fever, but when the drainage and cultivation are completed the unhealthiness is removed. The rainy season and the drying-up season are very unhealthy in malarious districts. "It is important to sleep well above the ground, and in an upper storey. The head and neck should be protected from the sun, alcoholic drink should be temperately used if at all, drinking-water should be boiled and filtered, and two grains of quinine taken night and morning."

Dr. H. V. Carter of Bombay, in an elaborate paper,[3]

[1] *History of Animal Plagues.*

[2] *Health: the Voyage to South Africa,* etc. Article IV. by Dr. Symes Thompson.

[3] International Medical Congress, 1881.

showed that—(1) Infection is always followed by fever. (2) With the advent and progress of pyrexia the blood parasites increase. (3) With cessation of fever they disappear. (4) By contact with the sick and inoculation of blood containing the spirillar organisms or their germs the disease may be conveyed to new or old subjects.

It appears to be perfectly clear that malaria, ague, or intermittent fever is caused by an organism flourishing in vast numbers in marshy soil containing organic matter in a state of decay; that it assumes a very severe character where, in addition to such matter, the filthy refuse of a population is intermixed and in solution; and also where a previously sodden, overflowed, alluvial deposit has become dried up, and its dust carried into the air by the influence of sun and wind. In the latter case, the spores or germs are probably introduced to the human system in much greater numbers than when pervading the moist air above a marsh. Cultivation and draining have the best effect in reducing the disease, for which the two conditions of a water-logged subsoil and an undisturbed surface appear necessary. The ague of the Eastern Counties has disappeared in a surprising manner with the drainage of the fens, and increased cultivation has likewise expelled the disease in other parts of the world. On the other hand, irrigation works, where careful provision is not made to dispose easily of surplus water, has increased the prevalence of malaria. Confined situations, where natural ventilation is hindered by hills or jungle, and the margins of certain lakes, the beds of dried-up rivers, and marshy estuaries where salt or brackish water sometimes overflows the land, are especially noted for malaria and other diseases depending on the same causes. The organism to which these diseases are due evidently lives best in a soil kept moist by a water-level not far below the surface, just as common mould appears on moist leather where ventilation is not free, and on the bindings of books which are somewhat damp and inclosed, but not on dry outer surfaces. Recent experiments on dew show that a part of the dew deposited on a clear night actually proceeds (as vapour) from below the surface of the earth.[1] The process of distillation appears capable of carrying up into the air the minute seeds of pathogenic microbes. It must therefore be very advisable for travellers or for an army encamped in malarious districts to cover the ground beneath the tent well over with impervious material. It is also important to be raised several feet above the ground, and to be screened at night, and whenever exposed to malarious emanations, by fine gauze or muslin, so that the microbes may be scattered, delayed, and enfeebled, before being breathed in or swallowed. This device is said, by experience, to be efficacious. It does not appear that the organisms can withstand for more than a very short time the action of *dry* air.

The chance of disease is also much diminished by avoiding sudden chills, wearing warm clothing, and, in fact, keeping the skin and circulation in a healthy condition. Scanty and improper food and long marches predispose. But in malarious places the most robust

[1] See "Some Remarks on Dew," by Colonel W. F. Badgley, *Quarterly Journal of the Royal Meteorological Society*, 1891. The present author has made a large number of experiments, which appear to show that on some nights there is a copious expiration of vapour from the earth.

frequently suffer. There can hardly be a doubt that contaminated water is a very frequent cause of malaria. After heavy rains, multitudes of malarious organisms are washed into the shallow wells, without undergoing that filtration through deeper strata which is so important; and, on the other hand, when the floods subside these microbes may become more concentrated where uncontaminated flood-water ceases to dilute them. Suspected water ought therefore to be boiled or filtered before being drunk.

Drainage and lowering of the subsoil water-level must be the most important measure, combined with the cleansing and ventilation of inhabited places, for the permanent reduction of malaria. The soil surrounding villages should be drained and the surface kept clean, the mouths of wells curbed and protected from filtration of surface-water, all houses well ventilated between the lower floor and the ground, and manure, etc., removed to a distance. Water from deep wells should be used. Many of the improvements which are efficacious in preventing cholera are of great benefit in reducing malaria and dysentery. A dry and clean surface of the ground surrounding habitations, cultivation of the ground, careful disposal of sewage, etc., pure water, tend to the increase of health and the reduction of the specific microbe.

Large tracts of country, however, such as the East and West Coast of Africa, the land between the Elburz Mountains and the Caspian, and many other riverine districts, seem to be beyond human control in the production of unwholesome emanations.

The neighbourhood of certain small areas might possibly be made habitable by either (1) drainage, or

(2) the use of mineral or olive oil to coat the surface of the lake or marsh when at the highest level, so as to cause a film of the oil to be deposited on the ground as the waters subside. Lime and soot might have some effect in preventing the emanation of potent malarious germs.

MEASLES.

Measles is caused by contagion or infection wherever met with.[1] In large towns, where sources of infection always exist, epidemics recur about every four years, chiefly among children, as fresh series of the susceptible grow up and become exposed to infection. Extremes of heat and cold, malarial soil, vitiated air, crowded dwellings, defective diet, increase the fatality of measles. Otherwise it is not usually a serious disease. The after effects, however, have to be guarded against. The incubation period is about ten or twelve days. During the period of incubation, for days before the rash comes out, infection is active. Measles is often mistaken for a cold or cough, and no separation effected till too late. In a school or family it spreads almost without fail, unless the disease is recognized from the very first. Children, therefore, who have been exposed to the infection of measles should not be allowed to mix with others between the third and twelfth subsequent days if infection is to be prevented. A case of measles is infectious for a week or so before the rash appears, and

[1] Quain's Dictionary. Dr. W. Squire.

a month after. The infection clings to clothing, wall-papers, etc., for a long time in an active state, and therefore disinfection of all articles exposed to it, and thorough airing, are imperative.

Organisms somewhat larger than those seen in vaccine-lymph were obtained by Dr. Ransome from persons suffering from measles. They were most abundant on the two days of greatest eruption. They have also been found in the skin in cases of measles.

Little attention has hitherto been given to the etiology and bacteriology of measles. It does not appear that the disease now arises "spontaneously," that is, without derivation from a previous case, but, probably, like other zymotic diseases, it was originally cultivated by filth and neglect.

Unlike scarlet fever, measles is rather increasing than diminishing. The question of isolation and notification is a difficult one. At Leicester, both small-pox and scarlet fever are kept down by rigid quarantine and isolation, and probably the same care would be partially successful with measles. But since adults are very liable to attacks of measles if they have not passed through it as children, and children are more easily kept apart and treated, it is doubtful whether without an international attempt at suppression, much benefit would result from the local isolation of children.

Dr. James Russell, of Glasgow, in a very instructive lecture on Infectious Diseases,[1] has stated that "we know exactly how scarlet fever, measles, and whooping-cough could be stamped out, or at least made as rare as typhus, small-pox, and cholera." "If they are not,

[1] *Epidemics: their Growth and General Prevention and Control.* Dec. 10, 1878.

it is simply because you will not permit us." The blame does not lie at the door of sanitary science. Some local authorities have included measles among the notified diseases, and have found the use of notification of great benefit in respect of school attendance.[1] Children coming from infected houses have been prevented from attending school; school closure and its serious interference with education has become less necessary, and the spread of the disease has been more or less controlled. If measles is to be effectually dealt with, notification must be in force before the rise of an epidemic. In the midst of an epidemic, the results of a hurried adoption of notification are not satisfactory. The value of notification depends on its being utilized in the application of measures of prevention to the first cases of disease which would otherwise result in an epidemic. The same course might be adopted in whooping-cough. These two diseases, measles and whooping-cough, caused in 1889 respectively 14,732 and 12,225 deaths, and presumably something over 300,000 cases of illness.

Dr. A. Campbell Munro, M. O. H. for Jarrow, has found by detailed experience of epidemics of measles, that school attendance is a very important means by which measles spreads among children.[2] In his Report for 1889 he shows how a child with the rash upon her was unwittingly sent to an infant school, and had apparently attended for three days in an infective condition. A fortnight later, in the week ending April 5th, there were 36 cases of the disease, 28 of them attending the infant department of the above-mentioned school.

[1] *Lancet*, June 6, 1891.

[2] *Public Health*, November 1890.

Twenty-six cases were notified from this school before any other case was notified from any other school in the town. The children attacked were scattered, in residence, all over the town.

Dr. Munro has observed[1] that in Jarrow the school attendance rose from 52 per 1000 of the population in 1871, to 68 in 1874; to 162 in 1882; or from 95 in the decennium 1871-80 to 164 in 1881-90. In the infant department of a Board School he found 69 children writing on slates in a space of 15 feet by 9 feet, less than two square feet per head. No such crowding took place in the streets or at home, while the conditions of mental fatigue and foul air were infinitely more conducive to infection than those in open air. Chemical and microscopical examination by Prof. Carnelley in Edinburgh of the air of schools, single-room dwellings, and bedrooms of a better class, gave the mean respective proportions of cubic centimetres of carbonic acid gas in a litre, of 18·6, 11·2, and 7·7, and the number of bacteria 151, 58, and 8·5. In one school the number of bacteria was not less than 600 per litre. When measles broke out in 1883, Dr. Munro, instead of closing the schools, kept the disease from assuming large proportions by close personal supervision, excluding all children from the infected houses so long as danger existed, and instructing the teachers to watch for the earliest febrile or catarrhal symptoms, sending home and reporting to him any cases that seemed in the least degree suspicious. The success attending this procedure convinced him that could such medical supervision be exercised over all schools, actual closure would rarely if ever be necessary.

[1] *Proceedings of Epidemiological Society*, May 20, 1891.

The periodic recurrence of measles depends of course largely on the presence of new and susceptible subjects, but also on the mean proximity of persons, or the density and sparseness of a population. According to Dr. Ransome, "these disorders can only become epidemic when the proximity between susceptible persons becomes sufficiently close for the infection to pass freely from one to the other." Dr. Munro was convinced that those medical officers of health who believed that all attempts to stay the progress of an epidemic of measles were futile, and that no good could follow from its notification, were in error. Compulsory notification was an essential condition of action. If this were given promptly, and all children from infected houses excluded from school, further steps might not be necessary. If, however, from six to ten new and independent cases had occurred within one week in an average-sized school, the infant department should be at once closed; in the senior department, close personal supervision and exclusion of any cases affording the least ground for suspicion would in most cases suffice. Infected houses should be noted to the managers of Sunday-schools, who should take similar action. Dr. Willoughby, who had for twenty years been connected with public elementary education, considered these proposals of the highest practical importance.

The influence of climate and weather upon measles is marked. It is a very persistent and spreading contagion, perhaps the most so of all the communicable diseases, save small-pox. It is a good disease for the study of the bacteriologist, "although no microphyte is yet authenticated."[1]

[1] State Board of Health, New Jersey, U.S.A. 1888.

The poison of measles is given out into the air surrounding the patient, and so the air in proximity becomes the chief infecting medium. It is largely spread in schools, and especially in infants' schools.

This and other diseases are sometimes spread through the agency of laundries.

Since one attack of measles is in most persons protective against the infection, the bulk of the population does not afford material for the continuance of the disease. If all children could have it at the same time, and thorough disinfection were carried out, the disease might be extinguished among mankind. If, on the other hand, a large proportion of the population were to grow up without passing through it, a single centre of infection might cause an infliction of measles to advance as surely as influenza, but much more slowly, across a country, the place of origin soon being lost sight of by the multitude of new centres derived from it through communication. The best means of reducing the severity and mortality of measles appears to lie in improving the sanitary condition of earth, water, and air, and of schools and dwelling-houses; it would also be desirable that the age at which measles is least severe and fatal should be ascertained.

ORIENTAL OR DELHI SORE.

THE disease known as Delhi, Sind, and Oriental sore, may be noticed as an instance of the dependence of a local malady on the nature of the water-supply.[1] The water of Delhi was extremely hard, and contained a large quantity of salts. Whether these ingredients favour the growth of a particular microbe, or so alter the condition of the blood that certain microbes within the body are enabled to live and evolve their poison in the blood-tissues, is of little immediate importance, so long as the necessary measures are taken to secure a wholesome water-supply for general consumption. All the wells from which the troops and population derived their only supply were largely contaminated, partly from the polluted subsoil, partly from extraneous substances and dead bodies which had been thrown in.[2]

Delhi sore is met with locally in other parts of the world.[3] It occurs chiefly at the most exhausting season. In Delhi it occurs also in dogs; and a similar disease in horses in India may be due to the same or a similar cause. The disease is considered contagious, and may be produced by inoculation. Immunity may pro-

[1] Report on Sanitary Measures in India, in 1875-76, p. 51.

[2] Douglas Galton: Address on Health. *Trans. Social Science Association.* 1873.

[3] Quain's Dictionary.

bably be obtained by general and personal cleanliness, the use of pure or boiled drinking-water, careful attention to the sanitary condition of the locality, avoiding overcrowding and contact with the disease in men and animals.

The water of the wells in Delhi was found to be so foul that it was compared to sewage, and bones were taken from some of them.[1] The disease is caused by bathing or washing in the foul water, which enters the body by sores, bites, etc. It is common on the noses of dogs in Delhi. It is well known on the Mediterranean coasts. The Parangi disease in Ceylon resembles Delhi sore, and is very fatal. Bad water is the reputed cause, and the means of prevention are obviously the same.

PLAGUE.

In the fifteenth century the countries in which the plague was habitually present, or recurred at intervals, included North Africa, Egypt, Western Arabia, Syria and Palestine, Asia Minor and Mesopotamia, Persia, probably India and China, and Europe generally.[2] This prevalence continued more or less throughout the sixteenth and seventeenth centuries. During the latter half of the seventeenth century the area of prevalence began remarkably to contract, and the process of decrease continued during the eighteenth century, so that only two serious outbreaks occurred—(1) in 1703-13

[1] *Transactions of the Epidemiological Society.* 1882-3.

[2] Quain's Dictionary.

in Turkey, Hungary, Russia, Poland, Austria, Bôhemia, and Eastern Germany; and (2) in 1720-22 in Provence. Up to about 1833 the disease had shrunk to the easternmost part of European Turkey, and in 1841 plague ceased altogether in Europe. In 1843 it came to an end in Asia Minor, Syria, and Palestine; and in 1844 in Egypt. Since that time, however, plague has several times reappeared in Persia and other Eastern countries within narrow limits. In 1877, a fatal bubonic febrile malady occurred in the district of Baku, on the Caspian shores of Transcaucasia, and in the same year the plague broke out at Resht in Persia. A non-fatal bubonic form of the plague occurred in Astrakhan. In October 1878, plague broke out on the Lower Volga in Russia.

Russian accounts derived the great plague of the fourteenth century from China,[1] where pestilence and destructive inundations are said to have destroyed thirteen millions.[2] In the sixteenth century, simultaneously with a terrible pestilence which is said to have nearly depopulated China, plague prevailed over Germany, Holland, Italy, and Spain. In 1656, the great plague of that period reached Italy, and in 1665 raged in London. The great plague at Messina in 1743 arose from an infected ship from Corfu. In 1815, an outbreak occurred at Noja, Italy, but did not spread, owing perhaps to extreme rigour of precaution. Many other outbreaks in the East were similarly stopped. Plague has been endemic in North Yemen, West Arabia; also in Irak, Mesopotamia, and the marshes of Hindieh. In 1815, it occurred after three years' famine in Guzerat,

[1] *Encyclopædia Britannica.*

[2] Mailla's *Histoire Générale de la Chine. Encyclopædia Britannica.*

Kattywar, and Kutch in India; in 1821, in Pali. It seems to have prevailed in the villages of the S.W. Himalayas in 1876-7, and on this and other occasions it has been said that the sign of its approach is the dying of rats and other animals.

The Egyptian origin of plague was universally admitted.[1] Its chief seats were Albania and the Barbary coast. In 1819, it was imported to Nuremberg in bales of cotton. It formerly broke out at Alexandria every year, and lasted from autumn till the following summer. It did not prevail in Upper Egypt, except when imported. In Lower Egypt it prevailed during south winds from pools and marshes of the Lower Nile, and ceased when the north wind blew. Brackish marshes and the soil deposited by the Nile appeared to maintain it.

A moderately high temperature is the most favourable to the plague; above 86° it declines. It has been considered unknown in the tropics. It is doubtful, however, whether it would not in favourable conditions extend to tropical countries, as it has been observed in moist air up to 95°.[2] It is checked by winter cold in the north; but there are exceptions to this: the Volga epidemic occurred in the winter of 1878-9.

The *Cause* which is most powerful appears to be uncleanliness. In Mesopotamia the ground is saturated with moisture and with a bluish-black oily fluid, which surrounds the huts and stains the walls at two feet from the ground. The people of India among whom the Pali plague raged were "filthy beyond description" (Francis). Overcrowded dwellings greatly favoured its spread. Poverty is a very powerful influence; many plagues have followed famines on the destruction of crops

[1] Brewster's *Encyclopædia*. [2] *Encyclopædia Britannica.*

and cattle. The races where plague is endemic are almost without exception under-nourished. It affects the poor chiefly in cities, as in Great Britain, in 1665, when dwellings, streets, floors, and walls were in a very filthy condition, and covered with organic pabulum which would probably afford a very appropriate breeding-ground for the plague microbe. It is both miasmatic and contagious. In India it breaks out at the same time in villages after years of immunity. It seems to be carried short distances by the air (hundreds of yards), but is carried chiefly by persons or things. In 1603, it hardly ever entered a house in London but it seized all living there. Prolonged breathing of the sick-room air was the most effectual means of infection. In these respects it resembled typhus. In Egypt, in 1835, two criminals who had been condemned were put in beds of plague victims and caught it. It may probably be conveyed by infected articles, but merchandise does not seem to have often transported it. It spreads in fact by human intercourse creating new foci.

The period of incubation is from three to five days. According to a Commission of the French Academy of Medicine sent to Egypt in 1844, the conditions which determined and favoured the development of plague were these—The first outbreak follows frequently on conditions of misery and famine. In this it resembles typhus. Dwelling upon marshy or alluvial soils, and on the banks of certain great rivers, the Nile, Euphrates, and Danube; a warm, humid air; low, badly-ventilated and crowded houses; great accumulations of putrefying animal and vegetable matter in the vicinity of dwellings; unwholesome and insufficient food; excessive physical and mental misery, and neglect of the laws of health, public and private.[1] Elevated sites are often exempt, *e.g.* the citadel of Cairo and the higher parts of Valetta. Upper rooms are less affected by plague than those near the ground.

The Bengazi outbreak followed upon four years' drought and failure of crops, and a fatal disease amongst cattle, which died also in large numbers from want of food. The plague in Maku occurred under similar conditions, but here the district was pervaded with the putrid emanations from the unburied carcases of cattle. In the outbreak on the Euphrates it was noted that the particular villages affected were on ground a foot or two lower than the surface of the water in spring, and the ground is so saturated with water that the refuse is neither absorbed nor evaporated.

The outbreaks of 1867 and 1873-74 had been preceded, according to Colvill, by the only two great inundations of the Euphrates which had occurred since 1831, the year of the previous latest outbreak in Bagdad. The outbreak in the highlands of Kurdistan in 1871 had been preceded by a fatal epizootic among sheep. Of these mountain villages Colvill says—"Whatever is most afflicting in poverty, whatever is most revolting in filthiness, is accumulated, as if designedly, around these infected dens, in the interior of which live, or rather vegetate, from fifty to sixty men, women, and children." The outbreak of 1874, in Bengazi, N. Africa, occurred when some of the favourite Arab camping-grounds had been converted into vast swamps from heavy and protracted rains, and when the people were reduced to the most abject misery, and were suffering from an extremity of famine. The outbreak

[1] See Quain's Dictionary; also Reynolds' *Dictionary of Medicine.*

of 1876 among the mountain villages of Kumaun took place in communities where people, cattle, and grain are packed together in horrible conditions of filth. The communities who suffered on the Volga, on the other hand, were prosperous, and believed to have plenty, but they were living in almost indescribable conditions of filth about their houses.

The plague finds a congenial home in the Himalayas; it was first noticed by a traveller, in 1823, and its visitations had become more frequent and virulent in 1850-51, when the inhabitants fled from the affected districts, and the Government, being unable to collect the revenues, instituted an inquiry.[1] The plague in these parts is known as Mahamurree. Dr. Francis and Dr. Pearson were engaged in an inquiry into the disease during two years, and they came to the conclusion that the Mahamurree was the same disease as the "Plague." The disease was highly contagious, but did not as a rule spread beyond the villagers, the temperature being higher in the plains, and the habits of the people cleaner. The conditions giving rise to the plague were as follows—The hill native of Gurhwal rarely washes; his woollen clothing is worn till it drops off; he lives in a small, over-crowded, almost hermetically sealed, hut of two compartments, the lower being occupied by the cattle, and the upper by the family (sometimes as many as thirteen persons), all available spaces being taken up by the baskets of grain, and the only hole in the wall is stuffed up with straw; old heaps of manure surround the house; and hemp and other growths, rising to eight or twelve feet, impede circulation of air in the village.

[1] *Trans. Sanit. Inst. of Great Britain*, 1879. Surgeon-General C. R. Francis.

Sanitary measures were carried out by Dr. Pearson, and, as a consequence, the plague in those hills, which used to show itself biennially and triennially, or even annually, has been practically extinct for the past twenty-five years (to 1879). During this period the disease has once or twice threatened to become epidemic, but it was discovered that a temporary relaxation of the sanitary regulations had led to the recrudescence.

Transmission of the plague is chiefly effected by the healthy breathing the same air as the sick, in the same house or in the same room, and less often by contagion. Clothes and bedding used by the sick also convey it. In plague, as in typhus, the liability of the healthy to contract it depends mainly on the constancy and intimacy of the relation with the sick. The effusion from body and breath is the chief danger, which is greatly reduced by mixture of free air.

The minimum period of incubation appears to be two, and the maximum eight, days.

For the prevention of plague it is quite clear that the primary conditions are cleanness and dryness of site and dwellings, and care for the purity of air breathed and water drunk. If cattle were well fed and cared for and excluded from dwellings, and dung and refuse were conveyed from the immediate surroundings of houses and villages; if overcrowding were avoided, and ventilation attended to; if clothing were kept tolerably clean, and if famines could be arrested, the plague, even if it should break out in exceptional circumstances, would easily be kept in check, and annihilated. Floods of great rivers are also always full of danger, and prepare the way for extensive outbreaks of epidemic disease. Marshy ground, especially if the inhabitants live in the most filthy conditions, is an important factor in many outbreaks of plague.

Any considerable increase in village sanitation, if such a thing can ever be expected in countries like Persia, Arabia, and Russia, would probably drive the plague to rapid extinction.

The greatly improved irrigation system of Egypt has its special dangers in the increase thereby of the dampness of the ground; but with constant attention to the uninterrupted drainage of irrigation areas, to village cleansing, and by the reclamation of marshy tracts, the recrudescence of plague, even in years of distress, may be prevented. It is important that the probability of a return of plague with improved irrigation in Egypt should not be left out of sight.

The prevention of spread of the plague in a civilized community may be secured without difficulty by sanitary measures, prevention of overcrowding, careful isolation of the sick, and disinfection of the room and all articles used by them. Ventilation is very important, and those in attendance on the sick should be impressed to rely chiefly upon fresh air and scrupulous cleanliness. All persons, travellers and others, who have been exposed to the infection, should be isolated, disinfected, and watched for at least eight days.

The retrogression of plague in Europe is one of the most striking instances of the effect of sanitary improvements and State regulations in reducing epidemics. The conditions of filth and neglect which still prevail to a high degree, are not sufficient to allow this microbe of the lowest depths of foulness and misery to set forth unchecked on a destructive westward march.

PNEUMONIA.

Pneumonia is now pretty generally recognized as associated with certain characteristic bacilli, and should be regarded as infectious, as in many outbreaks it has spread like other infectious diseases. The infecting power, however, seems to vary, possibly with the special character or virulence of the particular strain of microbe, as happens with some other diseases due to bacillar action. There are several kinds of pneumonia, and possibly a not uncommon appearance of the disease may be due to inflammation through cold, etc., unconnected with specific infection.

Cold and damp are exciting causes, also sudden changes of temperature. Constitutional weakness, poverty, and bad feeding, predispose. The age of maximum liability is from twenty to forty. An epidemic at Middlesborough, in 1888, led to an inquiry by Dr. Ballard, of the Local Government Board,[1] and he came to the conclusion that the disease was a specific fever, ranking as such with typhus, enteric, and relapsing fever; that it was infectious, through direct relation of individuals with each other, and probably also through the medium of emanations from drains, from sputa, etc., and infected food. Inhalation of slag and other dust predisposed; also chills, and fatigue. It is advised that

[1] *Public Health,* May 1889.

precautions be taken against pneumonia as against other infectious diseases.

Gamaleia gives as the result of his researches on pneumonia, the following discoveries[1]—He has always been able to recognize as the cause of the evil, the *streptococcus lanceolatus.* With certain reserves, which he fully details, he has always seen the microbe of Pasteur in cases investigated. In very susceptible animals, inoculation of the microbe causes death by acute septicaemia; in less susceptible animals, and in man, it causes typical fibrinous pneumonia. The microbe is common in the human mouth, but cannot attack the lungs while they are uninjured, and while the body is strong and healthy.

A number of experiments were made by Dr. Klein, with matter derived from the lungs of victims of the Middlesborough epidemic, and the bacteria are minutely described by him.[2] Heat of 75° C. for five minutes, and also complete dryness, was sufficient to kill the microbe. Guinea-pigs and white mice are strongly infected. Whether fed with infected food or subcutaneously inoculated with the microbe, 60 per cent. of these animals die. Pigeons and fowls completely resist infection. An epidemic of pneumonia broke out among the mice and guinea-pigs in Dr. Klein's laboratory, which were in the same room with those artificially infected.

In the spring of 1887, an epidemic of fever with pneumonia occurred at Witchampton, a small village near Wimborne.[3] Only the children attending school and their families were affected; about forty families. According to Mr. Parkinson, who reported upon it, the

[1] *Public Health,* November 1888. [2] *Ibid.* June 1889.
[3] *Ibid.* July 1888.

fever was specific, infectious, and of pythogenic origin. He considers that pneumonia of this form should be reported to the Medical Officer of Health, and should be considered apart from the pneumonia due simply to inflammation consequent on exposure to cold, etc.

Dr. Thomas Moore, of Dublin, claims that pneumonia should be considered a specific fever, exposure to cold, etc., only being a predisposing element.

Dr. George Giles concludes that pneumonia is a zymotic disease *always*, sometimes epidemic and infectious. An outbreak of pneumonia in the district of St. Marylebone showed strong infecting power,[1] for the disease attacked one person after another who had been exposed to its influence in the sick-room, and four deaths resulted in the same household. The house was in good sanitary condition as regards drainage.

By very interesting experiments Gamaleia showed that influences injurious to the pulmonary cells predispose to the development of the *streptococcus* in the lung. Cold, bronchitis, a fall, contusion of the chest, inhalation of irritating dust vapours, may give an advantage to the microbes against the macrophages which commonly seize and devour them. When in large numbers, as in the air of a room occupied by a pneumonic patient, the resistance of the body may be overcome by the microbes, and thus the disease spreads in a house, workshop, or city.

The *micrococcus pneumoniae* was discovered by Friedländer, and occurs in the sputa of pneumonic patients.[2] It has been cultivated on blood-serum,

[1] *Public Health*, April 1891.

[2] *Micro-organisms*, Griffiths. *Bacteria and their Products*, Woodhead. *Micro-organisms*, Klein.

nutrient gelatine, bouillon, and boiled potatoes. When the artificially cultivated microbe is inoculated in the tissue of the lungs, it has seemed to produce in animals all the characteristic symptoms of pneumonia. Inhalation experiments on animals explain how the inmates of a house become infected by the presence in the house of a single case.

The pleuro-pneumonia of cattle, which may be due to a similar, if not to the same, microbe, spreads by the movement of infected cattle through fairs, markets, auction-marts, and their reckless admission to the cowsheds of towns.

It is clear from these and other investigations that pneumonia has first to be guarded against by cleanliness, good air, brushing and use of antiseptics for the mouth; by maintenance of health and strength; by avoiding chills; by guarding against the inhalation of dust, as in factories (such as steel, wool, etc.), and irritating vapours; and next by treating pneumonia as an infectious disease.

The distribution of pneumonia is difficult to account for except on the hypothesis that it results from a common microbe either in places, or proceeding from certain soils and accumulations of filth, or else inhabiting the human mouth, and capable, on occasions of lesion or ill-health, or the slight inflammation consequent on colds, etc., of becoming pathogenic to the system.

There is much reason to believe that human sources of infection, scattered through the community, and dangerous only to those who are either in a weak state of health, or peculiarly susceptible, convey pneumonia to a much larger number of persons than might appear likely from the obvious distribution of the disease. In the West Falkland Islands, for two years at least, there appears to have been no case of pneumonia, and no case of broncho-pneumonia in children.[1] The inhabitants are always getting wet through, and hardly ever change their clothes, and yet they never get either pneumonia or rheumatic fever.

A similar immunity in the case of other remote islands and of ocean-going ships, may perhaps be attributed to the same reason as the absence of zymotic diseases generally, viz. removal from sources of infection. The necessity of thorough disinfection and use of antiseptic washes, after a visit to a pneumonic patient, has been abundantly proved, but is not generally realized. The poison is portable.

PUERPERAL FEVER.

No disease has brought with it darker sorrow than puerperal fever, and none is more surely reduced by human care and forethought. The experience of maternity hospitals has shown that even the atmosphere of hospitals may be so purified, and the conditions so improved, that a very large diminution of mortality invariably follows increased precautions against conveyance of the disease by doctor or midwife, increased cleanliness, and improved hygienic surroundings.[2]

At Helsingfors Maternity Hospital the mortality from this disease was, in the old hospital, 1859 to 1869, 7 per cent.; 1870 to 1871, 4 per cent.; 1872 to 1877,

[1] *Public Health*, June 1891.

[2] International Congress of Hygiene, 1891. Dr. Priestley.

1·11 per cent. In the new hospital, 1879 to 1883, 0·7 per cent.; 1884 to 1887, 0·29 per cent.

At Copenhagen, previous to 1865, the mortality in the hospital had been very high, as elsewhere. From 1850 to 1864 it was at the rate of 1 in 24. From 1865, immediately after the introduction of the antiseptic system, to 1874, the mortality was 1 in 51, and from 1870 to 1874 it was 1 in 87.

At the excellent hospital at St. Petersburg, supported by the Grand Duchess Catherine, and most carefully regulated, only one death had occurred during three years, and this was the case of a woman who was brought ill to the hospital. The mortality outside the hospital was very large at St. Petersburg.

Professor Slawiansky has given statistics of fifty-two maternity hospitals in Russia, and shown that just in proportion as antisepsis had been rigidly enforced, so had both puerperal illness and puerperal mortality declined.

At Vienna the mortality has declined from 13 to 4 per 1000; at Dresden from 8·7 to 0·7; in New York the deaths were reduced to less than one-fourth of the previous number; in Paris the mortality declined from 1 in 10·75 in 1858-69 to 1 in 43 in 1870-81, to 1 in 91 in 1882-88. At the York Road Hospital in London the rate was 30·8 per 1000 from 1833 to 1860, 17 per 1000 from 1861 to 1877, 6 per 1000 in recent years, and only one death from puerperal fever has occurred in three years.

According to a computation made regarding the total mortality in six European maternity hospitals, the rate has been reduced from 34·21 per 1000 under the old *régime* to 4·36 under the present system.

The increased care with regard to antiseptic and cleanly regulations in hospitals has unhappily not been equally employed by doctors and midwives in the outside population.

The fact was early established in the investigation of the disease, that it is conveyed easily from patient to patient by medical men, midwives, and nurses. It is conveyed by those who are pursuing pathological or anatomical studies in the dissecting-room. The influence of wounds is deadly; doctors and nurses who attend surgical cases, or cases of erysipelas, scarlet fever, septicaemia, etc., cannot for a long time attend a case of childbirth without serious danger. It is now recognized that the poison is always, or almost always, brought from outside, so that if the person, clothes, instruments, etc. of the attendant are perfectly clean and disinfected, the fever does not arise. No precaution is too great to prevent the conveyance of the microbe; it is considered that a doctor or nurse who has attended a case of puerperal fever cannot safely attend another lying-in case for some weeks or months, although cleanliness and disinfection are practised; and there is great danger of conveying the poison from surgical cases, or from the chamber of death.

According to Dr. Godson,[1] special sources from without are cadaveric matter, communicated by the hands of the practitioner after making post-mortem examinations, and septic matter conveyed by nurses on their hands or on sponges. It is also produced by infection from erysipelas. The constant and thorough use of antiseptics is well known to be a necessary safeguard against infection, but the previous attendance of the doctor on

[1] Quain's Dictionary.

cases which are a source of danger is not sufficiently guarded against. In this disease the extreme subtlety of the organic dust which clings to clothes and persons of intermediates, shows the way in which infectious diseases often spread, when we suppose that there can have been no exposure to their virus.

Dr. Cullingworth[1] has strongly recommended the use of antiseptics more generally in private practice, and has urged that every practitioner should recognize his individual responsibility. A very large number of deaths, and a very large amount of illness, occur through the neglect of antiseptic precautions and thorough cleanliness.

In the words of Wendell Holmes, who wrote on this subject, no tongue can tell the heart-breaking calamities these errors have caused; "there is no tone deep enough for regret, and no voice loud enough for warning."

RABIES AND HYDROPHOBIA.

Rabies is now known to be a contagious disease, transmitted from the diseased to the healthy animal by a bite or inoculation.[2] The period of incubation is very uncertain in accidental inoculation or bites, but definite in experimental inoculation. Of all the known con-

[1] *Public Health*, November 1888.

[2] International Congress of Hygiene, 1891. Also Papers issued by the Society for the Prevention of Hydrophobia.

tagious diseases, says Professor Fleming, rabies is the one which can be most easily and quickly extinguished. The dog is the chief propagator of rabies, and with the prevention of rabies in the dog, rabies and hydrophobia would be annihilated. The disease is suppressed already in several countries, and in others has never been allowed to exist. Sweden, Norway, Switzerland, Baden, Russia, Bavaria, Wurtemburg, and other countries have been freed from it by proper measures; Australia and New Zealand have never had rabies or hydrophobia, owing to the quarantine enforced on imported dogs. In Sweden the importation of dogs is prohibited. In order to suppress rabies altogether in England, the following measures are sufficient—Destruction of all dogs which are rabid, or suspected of being rabid, or bitten by a rabid dog. The seizure and destruction, after a few days' interval, of ownerless and wandering dogs. All dogs to wear a properly-constructed and well-fitting muzzle while rabies prevails, and also for a period equal to the longest interval of latency, after the malady has been suppressed. Quarantine for imported dogs.

As long as rabies and hydrophobia are permitted by nations to exist, the preventive treatment of Pasteur for persons actually bitten is of the highest value. The method will always be remembered as inaugurating a new epoch in the treatment of zymotic disease, and as a demonstration of a new means of saving millions of human beings from suffering and early death.

In 1888, the number of persons bitten by dogs proved to be rabid, who were inoculated at Paris, was 1371. Among these the total mortality, including those who came late and died during treatment, was 1·31 per cent. The mortality among all persons inoculated was

1·16 per cent. Since 1888, the rate has been reduced below 1 per cent.

Among these cases there were 280 cases of face-bites. Among persons bitten in the face and not inoculated, the mortality is 80 per cent., and among all persons bitten and not inoculated the mortality is 15 per cent.

Antirabic Institutes have been established in many countries.

At Warsaw, in 1889, 146 patients were inoculated, and one died. At St. Petersburg, among 484 patients inoculated, the mortality was 2·68 per cent. At Odessa, when the simple method was used, 3·39; in 1887, with the intensive method, among 345 persons, 0·58 per cent.; in 1888, among 364 persons, 0·64 per cent. At Moscow, in 1887, 1·27 per cent. At Turin, 1·88 per cent. At Palermo, 0·72 per cent. At Naples, 1·72 per cent. At Constantinople, 34 persons up to Nov. 1888; mortality, *nil*. At Havana, 0·60. At Bucharest, 244 persons; mortality, *nil*; 39 persons bitten by the same animals refused treatment; of these four at least died of the disease. In Hungary, in nearly three years, 552 were bitten; 62 were inoculated, and not one died; 470 were not inoculated, and at least 44 died. In Italy, by Luigi di Blasi, 343 were inoculated; mortality, 1·17. By Celli, 109; mortality, *nil*. By Baratier, 335; mortality, 0·59.

During four years nearly 7000 persons were treated at the Pasteur Institute in Paris, of whom 4500 were certified as bitten by rabid dogs. Of these seventy-one died, so far as could be ascertained by Professor Ray Lankester.[1]

The mortality of bitten persons in Russia previous to the discoveries of Pasteur has been stated at 50 per

[1] Report of Proceedings of the Mansion House Fund, 1889.

cent., and of bitten persons in other countries the average was fully 15 per cent. Wolf-bites, being usually on the face and hands, are the most fatal.

In 1888 and 1889, sixty-four English persons were treated; the mortality was *nil*, although ten were bitten on the head.

Pasteur, in a letter to Sir H. Roscoe, recorded his profound conviction that a rigorous observance of police regulations would altogether stamp out hydrophobia in the British Isles.

Rabies, which used to be very common in Berlin, has been completely put an end to by a law, extending to the whole of Prussia, which provides that all dogs suspected of rabies shall be immediately killed, also all animals which have been bitten by rabid animals; and that all dogs in a district which has been infected by an outbreak of rabies shall be confined, or, when abroad, both muzzled and led. No case has occurred in Berlin since 1883.

In Vienna rabies was entirely put an end to by rigid muzzling; but in 1886 the order was rescinded, and within a year the disease reappeared. Thereupon the muzzling order was put in force again, and is still maintained, so that the disease has vanished.

In the Grand Duchy of Baden, in the years 1871, 1872, 1873, 1874, 1875, the cases of rabies were 18, 37, 37, 50, 43. The muzzle was then rigorously applied, and the cases were as follows in 1876, 1877, 1878, 1879, 1880, 1881, 1882, 1883, 1884, respectively, 28, 3, 4, 2, 2, 2, 3, 2, 2. Of course these few cases still occurring were very likely due to importations, or dogs crossing the frontiers. Since 1884 only one case has occurred, and that was a dog from Metz.

In Sweden, rabies was common, and from eight to ten persons died annually of hydrophobia; after the enforcement of muzzling and prevention of importation, rabies declined, and no death from hydrophobia has occurred since 1870. The immunity of Mauritius has a similar history.

It is a popular error that rabies does not exist in Constantinople, for many cases have occurred there. The northern coast of Africa is a hot-bed of rabies. Cape Colony and South Africa were free from it until 1886, when a Maltese terrier, brought from Mossumelles, caused such havoc that many thousands of dogs were killed by the natives in order to get rid of the disease.

The mortality from hydrophobia has rapidly increased in England during the last thirty-eight years. The mortality during that period has reached the terrible total of 939.

In 1885, in London, twenty-seven persons died of rabies. A muzzling order was then enforced, and at the end of 1886 no death was recorded. Unfortunately the order was rescinded, a case soon occurred, and in 1889 ten deaths were registered. In July of that year the muzzling order was again issued and stringently carried into effect, and rabies and hydrophobia once more disappeared. This beneficent order was the means of saving men and animals from inconceivable suffering, and those who enforced it deserve the gratitude of the nation.

France and Belgium are subject to rabies to an appalling extent. Belgium has tried all recognized rules except the muzzle, and yet the malady is as rife and deadly as ever. A Royal Commission in that country has recently strongly recommended the adoption of the muzzle.

In Professor Fleming's opinion, and this is in accordance with the conviction of all the best authorities, "the United Kingdom can quickly and easily free itself from the disease, and keep itself free if it cares to do so; and a heavy responsibility for the loss of human life rests upon those who oppose, or do not choose to adopt, the measures indicated. Continental nations with coterminous frontiers should combine in a simultaneous effort to abolish a scourge which causes so much suffering and terrible death to man and beast. Such a consummation can be realized; it only needs the will to effect it."

Dr. Hime, who had had a good deal of experience in the observation of rabies and of Pasteur's method, declared that muzzling as carried out in England was often a perfect farce. In York the dogs on one side of the street were muzzled, while on the other side, which happened to be in another district, they were unmuzzled. A change in the law, which now allowed a dog its first bite, was urgently needed. The owner of a dog which inflicted an injury on a human being should be liable to prosecution.

Dr. Drysdale urged that all dogs in this country should be muzzled for a year, and then, when we had got rid of the disease, it would be easy to prevent its re-introduction.

These measures have for some years been most vehemently advocated, with the strongest possible reason and justification, by the Society for the Prevention of Hydrophobia and Reform of the Dog Laws. With regard to the importation of dogs from abroad, it has suggested that—(1) A special licence should be taken out at a port of arrival for all imported dogs. (2) Such dogs should wear a ticket of a special shape and character during the first twelve months after arrival. (3) The state of health of such dogs should be reported by owner at intervals of not more than three months, for the first year after arrival, to the veterinary inspector of the district in which the owner resides.

The *Lancet*, in remarking on the Society's objects, said—"It can only be regretted that there should be a *raison d'être* for such a Society. The Government, instructed by its scientific advisers, ought to have prevented any occasion for its existence. . . . We sincerely hope that the time is not far distant when the enforced muzzling of every dog in the kingdom, for at least six months, will give science the opportunity of testing its hypothesis."

The *British Medical Journal*, in an article on the Report of the Lords' Committee on Rabies, said—"Thus for the first time the splendid results achieved by the use of the muzzle, both locally in England, and generally abroad, are now recognized by the authorities, and its adoption strongly advised. . . . Let us hope that this Report will soon be acted upon, and then we may look for the banishment of rabies to the limbo where the black death, the plague, and other zymotic diseases extinct in this country, have been driven by sanitary science and preventive legislation."

The *Times*, in 1886, observed—"One thing at least is certain, and it is, that no one who has once seen a human creature die from hydrophobia, in torments too horrible to describe, would hesitate to muzzle every dog in the kingdom, if by so doing the extinction of the disease could be secured."

The *Field* also strongly supported the remedies proposed.

It is clear that the boon to animals of these mild repressive measures will be great. Their worst disease will be extirpated. With the best sort of muzzles dogs can bark, drink, hang out their tongues, but are unable to bite any one, or pick up garbage. This picking up of garbage is a frequent cause of serious intestinal troubles, from which the wearing of muzzles is a protection.

It is interesting to see how other diseases besides rabies are affected by the wearing of muzzles. Thus distemper was so reduced that, in the year of muzzling, at the Brown Institution only 78 cases were treated, as compared with 155 in the previous year. According to high authorities, dogs soon become accustomed to the muzzle, so that it is no more irksome to them than a bit to a horse.

Nothing can be clearer than that muzzling should be simultaneous and general. Local dabbing at this disease can only achieve a partial and temporary success. Ireland is almost constantly much affected with rabies, and importation is unrestricted. In 1887, the muzzling order in London stamped out rabies, but in consequence of the dogs in outside districts not being muzzled at the same time, the epidemic again advanced, and the order was not restored until ten human beings had lost their lives, a sacrifice to the criminal folly and selfishness of an insensate faction, who still cry out, as of old, "Let them be crucified." And the greater part of the tormented are little children.

ACUTE RHEUMATISM; RHEUMATIC FEVER.

This disease often arises after exposure to cold and wet, in an exhausted condition of the body, and prevails to a much greater extent in some districts than in others. The specific cause of rheumatic fever is not known, but the character of the disease makes it appear probable that a chill and the presence of a particular microbe, perhaps preferring certain kinds of soil, are required to produce the pathological phenomena. Rheumatism of a chronic kind may be induced by the presence of an acid which can evidently be evolved in the body or brought into the blood by a variety of conditions, especially by articles of food and drink. But in rheumatic fever the acid produced is probably the result of the action of a microbe which has obtained entrance into the blood or intestines, usually through the effects of a chill.

Avoidance of damp and chilly places, draughts, and especially damp houses, clothes, etc.; avoidance of over-exertion and of unwholesome food and drink, especially excess of wine, alcoholic drinks generally, and animal flesh, would greatly reduce the prevalence of this disease. Hereditary predisposition can be traced in 27 per cent. of cases. Possibly the disease may arise from chill acting on the organs of digestion, so as to admit the passage of a microbe common there to positions where it would multiply and evolve an acid passing into the blood and system.

The prevalence of chronic rheumatism and also of rheumatic fever would be largely reduced by proper clothing, and above all by the improvement of cottages and houses subject to damp. The number of houses built on damp ground, or without damp-proof courses, or without thorough ventilation underneath, is very great, and it is not surprising that many cottages in the country are constantly the abode of rheumatic affections. Built often of permeable material, the ground-floor below the level of the outside earth, surrounded by trees and bushes, and covered with mosses, lichens, and creepers, they seem constructed as a forcing-pit for disease. Concrete floors under cottages, thorough ventilation, raised floors, and damp-proof courses should be absolutely compulsory in all country places.

SCARLET FEVER.

Scarlet Fever is conveyed by some product of the sick and reproduced in the healthy. "No other origin for scarlet fever can now be admitted; its extension to any new locality is traceable to an imported infection."[1] The periodical recurrence of epidemics is mainly attributable to an increase in the number of the susceptible. Children are the most attacked. Even among people not protected by a previous attack, a less liability is noticed with advancing years. In adults the disease is less severe than in young people; infants often escape.

[1] Dr. W. Squire. Quain's Dictionary.

Scarlet fever prevails most in England and the United States. It has caused in recent times the highest mortality of any epidemic disease.

Cold and heat have little effect on the spread of the disease, but heat mitigates its severity.[1] In London the number of deaths from it is greatest at the end of October.

Defective hygiene greatly increases the dangers of the disease. Defective ventilation aggravates the type, and intensifies infection. Yet all the susceptible are very liable, however good their hygienic conditions. Mildness of type in the infecting source may turn to severity in the next case. Surgical operations increase susceptibility, and shocks or injuries often determine an attack. Many families are specially predisposed to scarlet fever. Acute rheumatism greatly predisposes to an attack of scarlet fever. This increase of susceptibility is notable in view of recent bacteriological discoveries.

Any person may be the carrier of infection; not only the hands that have touched the sick and things in actual contact with them, but clothes and even papers that have been in the sick-room may convey it. Infectiveness continues throughout the period of illness, and may last altogether eight or ten weeks. All objects exposed in the sick-room are dangerous, and the disease may be set up after a long interval, months or years, by objects, especially clothes, curtains, etc., which have been put away, and unpacked when all thoughts of danger were out of mind. A curtain put

[1] Apparent direct influences of heat or cold in epidemic diseases are often due in reality to increased or diminished ventilation, crowding, etc. The effect of change in human habits is greater than that of season alone, within certain limits.

away from the bed of a child only sickening with the disease has given scarlet fever after a long interval. Persons protected by a previous attack and others who have been exposed to scarlet fever infection may have a slight sore throat, and this sore throat is infectious, giving scarlet fever. Every case of sore throat in an infected house is capable of giving scarlet fever. Many people have scarlet fever only recognized by such a sore throat, and these cases are prolific in causing infection, through social gatherings and communication. Thus schools and parties are the means of producing many outbreaks.

The usual incubation period is about three days. Two to four days is common.

Inoculation reproduces scarlet fever. Animals may catch it, and are inoculable with the blood of patients.

Infection has many times been traced to milk. If it has been standing in the sick-room, or if it has been milked by a person who has been near a scarlet fever case, or if it has been exposed in a place where persons from an infected house have stood, it is dangerous.

Heat of 212°, applied to woollen clothing for a sufficient time, will disinfect.

Constitution and family predisposition have much influence in determining infection and the severity of an attack. The condition after surgical operations, and the puerperal state, produce special liability.[1] The wide diffusion of the germs of scarlet fever seems to be proved by the frequent occurrence of scarlet fever in persons with open wounds; but they are probably conveyed more commonly in clothes and domestic dust than in the atmosphere, for persons in remote isolated places

[1] Reynolds' *System of Medicine.*

unexposed to human sources of infection remain free from the disease. In ordinary conditions in England age and sex have no effect on the severity of an attack, and the robust are very liable to catch it in a severe form. Of course many adults are protected by a previous attack. Inoculation by means of the blood has been practised not without favourably modifying the course of the disease thereby communicated.

De Witt found ammonia, and Dr. Peart sesquicarbonate of ammonia, a sure remedy for scarlet fever.

There may be some ground for considering an alkaline condition of the blood protective against scarlet fever infection, and it might be worth trying whether children exposed to infection would be protected by small doses of ammonia.

The microbe of scarlet fever produces in the body an alkaloid, and an alkaloid having all the same properties has been extracted by Mr. Griffiths from a cultivation of *micrococcus scarlatinæ* in nutrient gelatine.[1]

Scarlet fever usually confers immunity from a second attack; but some few individuals are specially liable to repeated attacks, even to three or four times.[2] The same is the case with measles. Small-pox protects, but does not give absolute immunity against a second attack. Cholera and typhoid fever usually confer a certain degree of immunity against a second attack of the same disease, but in some cases the immunity conferred does not last more than a few years.

The maximum prevalence of scarlet fever in London in the seventeen years ending in 1888 fell three times in September, seven times in October, and three times

[1] *Micro-organisms*, p. 136.

[2] *Bacteria and their Products*. Woodhead, 1891.

in November; the minimum four times in February, four times in March, five times in April, twice in June, once in September, and once in December.[1]

The rise and fall of typhoid fever was on the whole very similar, the maximum occurring usually in October or November.

Dr. Gayton[2] considers it "utterly wrong to permit any scarlet fever patient whatever to mingle with persons susceptible to the disease until the expiration of seven weeks from the beginning of the illness, and in those cases where the desquamation is of late appearance, until the process is completed, and for a fortnight afterwards, nor then, until there is entire absence of discharge from the nose and ears, and unless the clothes worn on discharge are clean and thoroughly disinfected. "There are probably few medical men who are not alive to the intensely subtle virus of scarlet fever, and who cannot recount instances in abundance in which the most common precautions have been neglected." "Between slight and severe attacks it would be better to make no distinction."

An instance[3] is given by Dr. Underhill of the conveyance of scarlet fever to a family apparently by some Christmas cards sent to them which had been used by a boy who had played with them when ill with scarlet fever.

The researches of Dr. Klein and Mr. Power on outbreaks of scarlet fever and on a disease in cows led to the following conclusions—

1. The disease in man and in the cow is characterized by closely similar anatomical features.

[1] Report of the Statistical Committee of the Metropolitan Asylums Board. [2] *Public Health*, August 1889. [3] *Ibid.* August 1888.

2. From the diseased tissues of man and cow alike the same micrococcus can be separated, and artificial sub-cultures can be made from it.

3. The sub-cultures, no matter whether established from man or cow, have the property, when inoculated into calves, of producing in them every manifestation of the Hendon disease (except sores on teats and udders).

4. Sub-cultures made from human scarlatine and inoculated into recently-calved cows, can produce in those cows, along with other manifestations of the Hendon disease, the characteristic ulcers in the teats, ulcers identical in character with those observed in the Hendon farm.

5. Children fed on milk from cows suffering under the Hendon disease obtain scarlatina.

In 1869, Dr. Thorne Thorne had discovered that foot and mouth disease in the cow was capable of producing disease in the human subject. Derangement of the alimentary canal and herpetic eruption on the upper lip, feverishness, swelling of the lymphatic glands of the neck, were probably caused in children and adults by the use of milk from cows affected with foot and mouth disease.

Mr. Ernest Hart has given particulars of fifteen outbreaks of scarlet fever due to the use of infected milk, giving rise to 800 cases; but these were probably all due to human agency independently of disease in the cow. Of course, in some cases there may be a difficulty in tracing whether the disease occurred first in man or animals in any local outbreak; but we may take it as proved that scarlet fever sometimes arises directly from a disease in the cow without traceable previous human infection reaching the cow.

There is great probability of children being attacked with scarlet fever by the use of milk contaminated either by exposure to human infective sources or by diseased cows, and consequently the boiling of all milk should be habitual.

An outbreak of scarlet fever and diphtheria among the consumers of milk from a certain dairy at Newcastle was traced by Dr. Armstrong to the children of a man who had attended to the cows.[1] The man stated that his children "were all well, and never had scarlet fever or sore throats," but on examination, Dr. Armstrong found three out of the four children with signs of throat ailment, though they were not laid up. Bad throats had been prevalent where the man lived. The dairy was well kept.

The Medical Officer at Shotley, Mr. Elliston, has observed that there was some reason to think that an outbreak of scarlet fever there was connected with a deposit of London manure in the parish.[2] In the Samford rural district, Dr. Airy noted an outbreak of scarlet fever in Stutton, apparently caused by a heap of London manure recently carted into a field, on which heap the affected children played. Similar occurrences have been reported from other districts receiving London refuse.

The persistence of vitality in the scarlet fever microbe is illustrated by a story recently told by the *Boston Post.* A large picture-book had been used by a boy during his illness with scarlet fever, in 1846. The book was packed away in a trunk for twenty-six years. Finally, it was brought to England, and a child two years old became its possessor. A fortnight after receiving it, he was attacked with scarlet fever, and to the doctors attending the case there appeared no other

[1] *Public Health*, September 1888. [2] *Ibid.* October 1890.

means by which the child could have been infected.[1] There does not certainly seem to be any strong reason why germs which are known in similar conditions to remain potent over a year should not be capable of setting up the disease after a much longer period.

A medical officer gives several instances of the difficulties he has to contend with in arresting the spread of scarlet fever.[2] He has found children playing with another child with the rash upon her, and one of these children attending school ; in another case a mother attending on a child ill with the fever, and attending also on customers in the shop (a greengrocer's) ; in another, free visiting of the sick by healthy people, a woman and child, and a woman taking round milk ; in another a girl peeling, but dressed and mixing among others.

An instance of the persistence of the infection was given by Sir Thomas Watson.[3] A piece of flannel which had been a year before used for the throat in a case of scarlet fever, was playfully taken from a drawer by a housemaid and put round her neck. Though it was immediately snatched from her by an old nurse, the girl caught the fever.

Dr. Mackintosh, of Chesterfield, has shown the probability of the spread of both small-pox and scarlet fever by dogs and cats, which wander from house to house, and considers that when outbreaks of these diseases occur in a district, these animals should be fastened up, or prevented from conveying the germs of infection from one family to another.[4]

1 *Public Health,* January 1890. 2 *Ibid.* August 1891.

3 Lecture by Dr. J. B. Russell, M. O. H. for Glasgow.

4 *Sanitary Record,* April 22, 1876.

In epidemics of scarlatina, diphtheria, and typhoid, due to contaminated milk, there occur, in a number of houses having no direct communication with one another, sometimes singly, sometimes in batches, cases of these maladies, and on closer examination it is found that these houses have only this in common—that they are supplied by the same dairyman.[1]

In one case, recorded by Dr. Robertson, of Keswick, the milk was carried in an open tin-can through a yard where children desquamating from scarlet fever played. On one day between thirty and forty families in the town were attacked with scarlet fever, and all those who suffered received their milk from this dairy. Some member of every family supplied had either a scarlatina sore throat, or scarlet fever on this day.

But there are other cases in which there is very strong reason to believe that the cow was diseased, and that the scarlet fever was not conveyed directly by human subjects. A sudden outbreak of scarlatina was noticed by Mr. Winter Blyth in Marylebone in December 1885, and this was traced to a farm at Hendon. (For full account see Report of the Medical Officer of the Local Government Board for 1886.) Other outbreaks occurred at the same time in other parishes supplied by the same farm. By careful inquiry, Mr. Power was able to exclude contamination by a human source. Only certain cows were concerned in the production of the disease, and these cows were in a condition of disease caused by infection from others recently brought from Derbyshire. This disease in the cows greatly resembled scarlatina. The milk of these cows

[1] *Etiology of Scarlet Fever.* Klein, Proc. Royal Institution. 1887.

gave scarlatina to human beings. A particular microbe in the ulcers of these cows gave, when inoculated into calves, a similar disease to that of the cows. In the blood and tissues of persons ill with scarlet fever there occurs the same micrococcus as was present in the cow, both being identical in microscopical and cultural characters. The action of this microbe on animals was exactly the same as that of the microbe of the Hendon cows, calves and mice being affected with a disease greatly resembling scarlet fever. The cow is found to be susceptible to infection with human scarlet fever, and men may be infected from the cow.

The *micrococcus scarlatinæ* was also found by Dr. Klein in tins of cheap condensed milk of a particular brand, and produced the Hendon disease in animals. The tins of milk had not been sufficiently heated, and several contained other living microbes.

The great outbreak of scarlet fever at Wimbledon was traced to a particular farm. A monkey which drank a good deal of the milk died of scarlet fever, and Dr. Klein obtained from its blood the same micrococcus. Inoculation and feeding animals with this produced the same results.

Preventive measures against such outbreaks are threefold: Prevention of infection of the cow by man, of cow by cow, and destruction of the contagium of milk.

The disease in the cow is mild, showing itself on the udder and skin, and by visceral disorder not easily discovered. It is clear that every dairy should be permanently under the supervision of an expert. With regard to the destruction of the contagium in milk, heating the milk up to 85° C. or 185° F. is sufficient to destroy the vitality of the microbe. Those who boil their milk escape milk epidemics, and the importance of heating milk to at least 185° F. or boiling it should be known in every household. With regard to cream great care should be taken to ascertain the condition and management of the dairy supplying it.

According to the results of researches by Mr. Arthur Mitchell and Mr. Alexander Buchan [1] on the relation of weather and season to disease, scarlet fever in London has a constant tendency to increase in the late summer and autumn, reaching a maximum in October or November. "The thing which we call an epidemic of scarlet fever turns out, when minutely examined, to be simply a great intensification of what is an annually recurring feature in the natural history of the disease."

If we may venture to speculate on the reasons of this annual increase, the probability appears to be that a rather high temperature is favourable or necessary to the development, in outside conditions, of the micrococcus of scarlet fever. The filthy farm-yards and manure-heaps which abound in all parts of the country may furnish a suitable soil for the growth of this microbe, and it may then be easily transplanted to the bodies of animals and men. Possibly some special kind of manure may be required for its nourishment, just as the fungi and mushrooms which spring up so freely in the late summer and autumn need special soils and special conditions for their vigorous growth. Scarlet fever might thus infect many children direct from natural outside cultures, and from these it would spread in the well-known ways of infection from case to case. The re-assembling of school-children in September would

[1] *Proceedings of the Royal Institution of Great Britain*, 1881 See also *Trans. Sanit. Inst.* 1882-3.

also tend to cause a great deal of scarlet fever by the usual means of spread, and, consequently, a maximum in October or November.

The means of prevention of scarlet fever, according to present knowledge, may be summed up as follows—

1. Improvement of the conditions in which farm animals, especially cows, are kept. Abolition of the straw-yard, or manure-yard, with its mass of rotting filth, in which cows are accustomed to stand and pick about. Good paved, sloping surfaces, and collection of liquid manure in tanks for use on the land, should be substituted. Economy in the saving of valuable manure, in the cows' health, and in human health, would follow. The cowshed or byre should be well-paved, drained, and ventilated; not as at present in the majority of farms, dirty, sodden, and crowded. This reform is highly important for the sake of the animals' health. Cleanliness has been *proved* not only to prevent much serious disease in animals, but to raise their condition, weight, and milking qualities.

2. Separation of diseased cows from healthy, and stopping the distribution of their milk. Skilled supervision of dairy-farms and dairies by the medical officer or other qualified man.

3. Removal of all needless draperies, garments, furniture, etc., from the room in which a scarlet fever case arises, and thorough disinfection or destruction. A sheet soaked in a solution of carbolic acid should be hung outside the door, covering it.

4. All bed and body linen should be plunged into water containing a disinfectant (of real strength and efficacy), immediately on removal from the patient, and *before* it is taken from the room.

5. Pocket-handkerchiefs should not be used, but small pieces of rag, which should be immediately burnt.

6. The nurse to wash in disinfectant water, not to mix with the family, and to wear washable dresses.

7. All glasses, etc., used by the patient to be cleaned in boiling water before being used by other persons.

8. All discharges from the patient to be received in vessels with strong disinfectants.

9. The sick-room to be well ventilated; the lower sash may be raised two or three inches, and a piece of wood of equal length be placed underneath it, so as to admit air between the sashes.

10. Thorough disinfection of the room when the patient is convalescent, and washing of all washable articles thoroughly with disinfectants. The floor and walls must be cleansed with strong disinfectants, and the paper stripped off. Since all the particles given off by the skin must be considered as carriers of the microbe, the oiling of the surface of the body with olive oil has been strongly recommended, during convalescence, and the use of warm baths with disinfecting soap. The subject of scarlet fever is usually considered safe, as regards infectiveness, after eight weeks.

In the case of farm-servants and milkers or their children suffering from scarlet fever, particular care as to destruction of clothing, isolation, and removal from proximity to dairies is imperative.

Communication between medical officers, doctors, and school-teachers and managers is important in order to prevent pupils from returning in an infectious condition, either at the beginning of an attack or after it.

Communication between local authorities all over the country, and between these and a central authority, is indispensable for the suppression of scarlet fever. Our present inefficient arrangements give in this respect better chances to the microbe than to man. The chief of the Metropolitan Fire Brigade has an organization to suppress fire over a large area; the chief of a Fever Brigade must have the whole country under his eye if we desire to extinguish fever. He must study and enforce the conditions of security both for men and for animals.

SMALL-POX.

Nothing is known of the origin of small-pox; but it appears to have come originally from the East, and to have been known in China and Hindostan from time immemorial.[1] "The disease travelled slowly westwards, for communication was very tardy in those days, and it seems to have reached Constantinople by way of Egypt about the year 569." From Constantinople it spread gradually over the whole of Europe, reaching England about the middle of the thirteenth century. Sweden was not visited till 200 years later. It was imported to America in 1527. Australia and New Zealand were free from it for many years after their discovery. Since small-pox exists only through infective cases and infected things, isolation and disinfection in all civilized countries will eventually stamp out the disease altogether.

Small-pox was formerly thought to depend on a peculiar condition of the atmosphere.[2] Boerhave pointed

[1] Health Lectures for the People. Edinburgh, 1884. Dr. Rutherford Haldane. [2] Reynolds' *System of Medicine.*

out its infectious quality. Sydenham, who paid so much attention to small-pox, overlooked its infectiousness.

Small-pox spreads in a population both by the dried and pulverized crusts which come from the body of the person attacked, and by the breath. The breath is dangerous before the eruption has appeared on the body. A single breathing of the air where the corpse of a person who has died of small-pox is lying is enough to give the disease to susceptible persons. The dry scab of small-pox remains for years potent for inoculation.

An instance of the extreme infectiousness of the disease is given by Dr. Marson. A lady met in the street a person with small-pox; in twelve days she was attacked with the disease, and in twelve days more her sister suffered, although the first had no eruption.

In small-pox pustules micrococci are found, and the same microbes may be observed on the pustules of the mucous membrane of the larynx, in the liver, the kidneys, and the blood of the vena porta.[1] They are also seen in cow-pox, and the microbes of vaccinia are *apparently* the same. When the vaccine virus is deprived of its micrococci by filtration it is rendered inert.

Inoculation was known to the Arabs and Chinese as early as the tenth century, but was not encouraged by their physicians. In India it was practised by Brahmins. When first introduced in England, it was condemned by the clergy, as opposed to the will of Providence. It was condemned by the Sorbonne in a decree as "unlawful and contrary to the law of God," a decree officially confirmed by the Faculty of Medicine in 1763.

Vaccination was introduced early in the present century, its discovery being due to the observation by

[1] *Microbes, Ferments, and Moulds.* Trouessart.

Jenner and others that farm-servants who had been affected by cow-pox were secured against small-pox.

Small-pox is communicated by all kinds of articles which have been in contact with a small-pox patient, or exposed to emanations in the sick-room.[1] There are instances of communication by direct contact, by emanations, by flies, by clothing, by books from circulating libraries, by pence, by letters, etc.

During the whole period of illness a clean cotton robe and cap should be hung up in a sheltered place outside for the use of the medical man. The doctor should leave his hat and gloves outside the house, and use ablution after he has removed the robe and cap.

In small-pox no dependence can be placed on gaseous disinfectants; the organism appears to be inclosed in a cell with tough walls. Wherever an outbreak occurs, or an epidemic threatens, temporary hospitals should be erected; railway-stations, public places, schools, and churches should be well watched, and no nurses in attendance on cases should be allowed to mix with the population. Librarians of public libraries should require a certificate of the non-existence of small-pox in the house of the applicant.

Micrococci have been found in the lymphatics of the skin in small-pox (Weigert), and in cow-pox and sheep-pox (Klein) in the vicinity of the pocks.[2] The same micrococci were found by Cohn in the lymph of vaccina and variola. They are 0.5 μ in diameter. If the lymph is filtered through a Chamberland filter, the filtrate loses its infectious properties, so that the microbes which are filtered out are the active causes of small-pox. The

[1] *Dictionary of Hygiene.* Dr. Winter Blyth.

[2] Griffiths' *Micro-organisms.*

micrococcus vacciniæ occurs singly, in pairs, in chains, and in colonies. According to Klebs, variola is equally transmissible by air and by inoculation of micrococci.

The average duration of immunity from small-pox through vaccination is ten years. Vaccination does not protect a person who is already infected with small-pox. (But see *post.*)

The original seat and mode of origin of small-pox is not known. It spreads now from contagion and inoculation. No climate, race, or age is exempt.[1] In Europe, America, and India, its subjects are unvaccinated or badly-vaccinated persons. The rarity and mildness of small-pox depends on efficiency of vaccination. As a rule, it attacks the same person only once. The period of incubation is about thirteen days. Persons under fifteen years of age, with two good vaccination marks, are rarely attacked, and if any contract it, death is almost if not quite unknown. After this age, however, attacks may occasionally be severe. After successful re-vaccination, small-pox is almost unknown.

During the epidemic of 1871, 110 persons were engaged in the Homerton Fever Hospital, in attendance on the small-pox sick. All these, except two, were re-vaccinated; and all but the two escaped small-pox. In the epidemic of 1876-77 the experience was the same; all re-vaccinated attendants having escaped, whilst the only one who had not been vaccinated died of the disease. In the epidemic of 1881, of ninety nurses and attendants in the *Atlas* Hospital ship, the only person attacked was a housemaid who had not been re-vaccinated. It is not safe to assume, however, that re-vaccination will certainly protect for a whole lifetime.

[1] Quain's Dictionary. Dr. Collie.

The experience of the London Small-pox Hospital shows that, in unvaccinated persons, small-pox runs an unmodified course in all but 2·6 per cent. of the patients; in vaccinated persons it is modified in 73 per cent. of the cases; that the death-rate in cases of unvaccinated persons is 35·55 per cent.; in vaccinated persons 6·56 per cent. In later years, however, the rate among the vaccinated has been as high as 8 per cent. In nearly all the fatal cases the vaccination was found to have been imperfect, and not done according to the best rules.

The mortality for good marks during the years 1871-78 was 4·1 per cent. of cases; for indifferent marks 10·5. To produce at least four perfect vesicles, leaving four characteristic cicatrices, should be the object of every vaccinator. Very many persons have been imperfectly vaccinated in infancy; these should be re-vaccinated. It is desirable, for the prevention of small-pox, that all persons should be re-vaccinated between ten and fifteen years of age. Re-vaccination often fails, and should therefore, where possible, be done direct from the arm. The greatest precaution should be taken in every case as to the person from whom the lymph is drawn, the cleanliness of the instruments, and the manner in which the lymph is drawn, avoiding any vesicle from which blood may have been accidentally drawn. The Government instructions are now so full and precise, that the deplorable failures and accidents which have certainly occurred, though very rarely, ought to be altogether avoided.

Confluent small-pox is fatal to about 50 per cent. of those attacked. It is very rare among vaccinated persons.[1] "Small-pox is decidedly an infectious and contagious disorder. Riding in a cab or omnibus in which a patient has been recently, or even passing him in the street, may give the disease."

At Norwich, out of 215 unprotected members of families, 200 contracted small-pox and 46 died; while of 91 vaccinated, only two took the disease, and these had it in a modified form. At Chelsea, out of 757 individuals in infected families, 526 were unvaccinated; and of these *all but seven* took the small-pox; while of the 231 persons protected by vaccination, only 27 caught the disease.

The mortality from natural small-pox is seldom below 20 per cent., and often amounts to 30 and even 40 per cent. Among those who have been vaccinated the death-rate is generally 3, 4, or 5 per cent., and is rarely known to exceed 7. In Bohemia, where observations have been made for 21 years on four millions of people, the death-rate among vaccinated patients was $5\frac{1}{16}$; among non-vaccinated, $29\frac{4}{5}$.

The following table shows the results of a long series of years at the Small-pox Hospital in London—

	Number of Deaths per cent. in each Class.
1. Unvaccinated	37
2. Stated to have been vaccinated, but having no cicatrix	23·57
3. Vaccinated :—	
(*a*) Having one scar	7·73
(*b*) „ two scars	4·70
(*c*) „ three scars	1·95
(*d*) „ four or more scars ...	0·55
Having previously had small-pox	19

[1] Haydn's *Domestic Medicine*. By Edwin Lankester, M.D., F.R.S., and others.

In Mauritius, the mortality among the non-vaccinated was 42·7; among the vaccinated 7 per cent. In Ceylon, the well-vaccinated were about one-third less in mortality than the unvaccinated. In all countries the mortality from small-pox has been very largely reduced by vaccination; in many to about a tenth of what it was last century. In England, it is about a tenth of what it was at the end of last century, though a few years ago it was found that 12 or 13 per cent. of the children of school age were unvaccinated.

If every child were well vaccinated and re-vaccinated before fifteen, small-pox in England would almost cease to exist, though a few cases would of course be imported from foreign countries. At the Small-pox Hospital, every nurse and attendant is re-vaccinated, and during thirty years no case arose among them.

By vaccination in infancy, if thoroughly well performed and successful, most people are completely insured, for their whole lifetime, against an attack of small-pox.[1] Hitherto there has been a very large amount of imperfect vaccination, and some of these may contract as severe forms of small-pox as if they had never been vaccinated. Partly because of the existence of imperfectly vaccinated persons, and partly because in some persons the best vaccination in course of time loses its effect, it is advisable that all persons who have been vaccinated in infancy should, as they approach adult life, undergo re-vaccination. In circumstances of special danger, every one past childhood, on whom re-vaccination has not been successfully performed, ought without delay to be re-vaccinated. Re-vaccination, once properly and successfully performed,

[1] Memorandum of the Privy Council, 1871.

does not appear ever to require repetition. Re-vaccinated nurses, living in the most constant attendance on small-pox patients, and others exposed to special chances of infection at the Small-pox Hospital have never been affected with small-pox during thirty-four years.

The efficiency of vigorous measures of isolation and disinfection, with constant vigilance, is well shown by the experience of Leicester from 1873 to 1883, during which time several outbreaks of small-pox, usually imported, were promptly dealt with and suppressed. During these ten years the deaths from small-pox in eleven large towns were as follows—[1]

London, 8810	Manchester, 310	Nottingham, 58
Birmingham, 1085	Bristol, 131	Sunderland, 53
Liverpool, 825	Leeds, 217	Leicester, 19
Salford, 494	Newcastle, 131	

In London, Dr. Buchanan ascertained that the mortality in children under ten years of age was about a hundredfold greater among the unvaccinated than among the vaccinated.[2] In the year 1881, it was estimated that the lives of 12,000 children were saved by vaccination. The mortality among the privately vaccinated was about double that among the publicly vaccinated.

A great deal depends on the completeness with which the process of vaccination is carried out; the scars should not be less than four or five, and should together cover at least a square inch of surface. According to the Report of the Vaccination Committee of the Epidemiological Society, small-pox patients up to twenty years

[1] Reports of Medical Officer for Leicester.

[2] Report of the Medical Officer of the Local Government Board, 1881.

after vaccination, having evidence of good vaccination, die at a rate from $\frac{2}{80}$ to $\frac{5}{80}$ of that of unvaccinated patients at corresponding ages.[1]

The German Vaccination Committee reported that since the establishment of compulsory re-vaccination at the age of twelve, in Germany, as a whole, small-pox has diminished to a degree never before known, so far as any records reach, whereas in all neighbouring countries small-pox is, as usual, still very prevalent; that the German large cities suffer scarcely at all from small-pox; that the German army is almost free from small-pox, while other armies still suffer severely; and that not a single death from small-pox has occurred in the Prussian army since 1874, whereas both the neighbouring Austrian and French armies still show considerable losses in this respect. [These observations appear to have been made in 1885.]

Dr. Thorne says, it is now generally admitted that aggregations of small-pox patients do cause an increase of small-pox in their neighbourhoods, and Mr. Power's contention that a hypothesis of the conveyance of the contagion through the outside air can alone explain the circumstances of the diffusion, now meets with the almost unanimous support of competent, scientific judges.

This diffusion through the air to some distance is not only very intelligible, but might naturally be expected from what we know of the infectious matter of small-pox, which has the qualities of persistence for a long time in infected articles, transmission by the crusts and by emanations from the patient, potency in very small quantity, and insensitiveness to oxygen and light.

[1] Dr. Thorne Thorne on *The Progress of Preventive Medicine.*

A full and excellent paper[1] by Sir John Rose Cormack, M.D., demonstrates the experience of Paris with regard to the diffusion of small-pox from its hospitals.

In the arrondissement in which the chief small-pox hospital was situated, the mortality from small-pox during two months exceeded the proportionate mortality of all Paris from twenty to twenty-one times. The mode of diffusion was, in the author's opinion, to a large extent by direct personal communication, a circumstance which prevents us from estimating the extent to which epithelial drift disseminated the disease. Saint Antoine and Sainte Eugénie are large general hospitals, to which crowds of out-patients daily repair, and it was by them unquestionably that small-pox was chiefly propagated, and "is still being propagated in the vicinity of these two hospitals." "To a large extent, I doubt not, the spread might be checked by suppressing the out-patient department, and preventing by police supervision all intercourse between the outside population and small-pox wards." But no police system can entirely remove danger from the vicinity. "The history of the spread of the disease in the vicinity of the Annexe of the Hôtel Dieu is the history of *spread by epithelial drift, which no system of police can intercept.*" A depôt of small-pox patients must be a source of danger; the only means of lessening the danger is by preventing its leaving the patient in a dry state, or destroying it on the premises.

In the neighbourhood of another hospital, the Laennec, small-pox did not spread. In this hospital the

[1] *Trans. of the National Association for the Promotion of Social Science.* 1880.

ward-sweepings were at once burnt, a measure to which Sir John Cormack attaches capital importance. Possibly, he says, if the patients at the Annexe of the Hôtel Dieu had been diligently smeared with oil, and the ward-sweepings had been regularly burnt at short intervals, there might have been no spread of small-pox by the wind. Still, safety would be contingent on the minute, constant, and conscientious discharge of irksome duties by nurses and ward-servants. He concludes that—1. Small-pox patients ought not to be isolated in depôts situated in or near dirty, crowded, closely-built districts, nor contiguous to an imperfectly vaccinated community. 2. They ought to be isolated in special hospitals, in which only small-pox patients are received. 3. Frequent inunction of patients and burning of ward-sweepings, etc., must be practised. 4. Isolation must be made absolute from the external population.

Sir John Cormack gives an instance of a small epidemic of small-pox in Paris, which had the appearance to the medical men of spontaneous origin in a number of different houses. It was ascertained, however, by Dr. Trousseau, that every one of the first persons (seventeen altogether) seized in each family had made purchases at a particular linen-draper's shop, in the inner compartment of which, divided off by a screen, lay the daughter of the shopkeeper ill with small-pox. This experience shows how easily small-pox is conveyed through air, and how hidden the means of infection often are.

The ease with which small-pox spreads from a single case was well illustrated by an outbreak at a Roman Catholic Industrial School in Manchester; from an undiagnosed mild case of small-pox in one child forty-six children were infected and removed to hospital in one day.[1]

A consideration of the distribution of the disease in the neighbourhood of the Homerton Small-pox Hospital led Dr. Tripe to the conclusion that the infection extended directly through the air to a rather long distance.[2] "If it be admitted that the infective matter of this disease can be carried twenty or thirty yards—and a large proportion of those who have paid any attention to the subject admit this—I cannot see any reason why, under favourable atmospheric conditions, including a low velocity of the wind, it should not cause the disease at a much greater distance. . . . The modes by which the infection spreads may be briefly stated as being by the intermixture with the outside world of persons who have come from the hospitals, or from other infected places; by ambulances; by infected clothing; by persons suffering from the disease; and as I believe by the air." Of the 859 cases removed from the Metropolitan parishes on the north side of the Thames during May 1884, 285 belonged to Hackney, 143 to Bethnal Green, 86 to Shoreditch, and 66 to Islington, making a total of 570 from Hackney District and adjoining parishes. The death-rate from small-pox in ten years among the better-class population living at some distance from the hospital was 0·22 per 1000, against 4·13 among those living near it, and 1·61 among those of a similar class beyond the quarter-mile radius. The cases in 1881 were 126 per 1000 houses within a quarter of a mile, 95

[1] *Public Health*, September 1888.

[2] *Small-pox Hospitals.* By Dr. Tripe, M. O. H. to Hackney 1884.

between the quarter and half-mile, and 31 outside this circle. In 1883-4 the cases were 158, 92 and 22 respectively.

These facts so clearly given by Dr. Tripe, seem to show that a small-pox hospital is a real source of disease to the neighbourhood, and capable apparently of distributing it through the outside air. But probably a large proportion of cases would be abolished by greater care for isolation and the destruction of dust and refuse in the hospital. Sufficient reason remains for treating not only hospitals, but every small-pox case, as disseminators of small-pox dust, and therefore the greatest care should be taken to ensure perfect isolation, the burning of all dangerous matter, and the passage of air from the sick-room through fire.

For the suppression and eventual annihilation of small-pox in civilized countries the following measures are likely to be sufficient—

1. Careful and thorough vaccination and re-vaccination. 2. Vigilance at ports and isolation of imported cases, followed by thorough disinfection; or, better, complete destruction of infected articles. 3. Isolation of cases, of which a few might still rarely occur among imperfectly vaccinated persons as long as passengers and goods enter from countries subject to small-pox, such as India, China, and other parts of Asia, Africa, and South America. 4. Inunction of cases, and passage of air and dust from sick-room through fire. 5. Isolation for three weeks of unvaccinated persons who have been known to have been exposed to infection, and disinfection or destruction of their clothing.

As long as small-pox remains a virulent scourge in unprotected communities, and so many persons are imperfectly vaccinated, it is impossible safely to neglect either re-vaccination or isolation. If re-vaccination were universally and thoroughly performed, isolation would scarcely be needed, and if isolation and prompt treatment of every case of small-pox could be everywhere relied on, vaccination, except in those persons exposed to known danger, would be less important; but since these conditions, in a country having vast intercourse with all parts of the world, are quite unattainable, vaccination, re-vaccination, and isolation must all be employed to keep our population free from this plague. Examination and disinfection of suspected imports, and constant vigilance with regard to ports of embarkation and shipment are indispensable. The action of the Leicester Sanitary Authorities and of the Metropolitan Asylums Board in the isolation of cases has met with very great success, and, in combination with other evidence, leads to the conclusion that in fair sanitary conditions of soil, water, and air, all infectious diseases can be reduced to small proportions by the three measures of Notification, Isolation, and Disinfection or Destruction. Similar success rewarded the efforts of the Hastings Sanitary Aid Association, of the Westminster Aid Association, and of other volunteers in the cause of life-saving in towns.

The proper action on the occurrence of an outbreak of small-pox is exemplified by the method used at Bradford in 1889 by Dr. MacLintock.[1] A young man employed by the Tramways Co. fell ill with small-pox; his brother, who worked at a mill, was at once sent home, and on the same day the whole family was removed to the "isolation house." Their dwelling was

[1] *Public Health*, January 1891.

thoroughly cleaned and disinfected. It was found that the man first attacked had lived for three weeks at a common lodging-house. On the day following that on which the man was removed to hospital, another man in this lodging-house was found with small-pox. He was removed. Arrangements were at once made with the landlord to admit no more lodgers, and for the Sanitary Committee to take the place for a fortnight or three weeks. All the twenty-three inmates were inspected, and nine were re-vaccinated. They agreed on favourable conditions to remain in the lodging-house until it was safe for them to go out. With the help of inspectors constantly watching him, this arrangement was strictly carried out. The whole of their clothing was twice disinfected, and the house thoroughly cleansed. No other case showed itself in this house afterwards. Another man was taken ill with small-pox, who had occasionally stayed at the lodging-house. The police had been instructed to look out for him, and he presented himself at the charge-office in the Town-hall. He was sent to hospital, and the charge-office disinfected. He had lately slept at several different houses, and when these had, with some difficulty, been discovered, they were treated exactly like the lodging-house, a considerable strain being thus thrown on the resources of the Sanitary Department. Several members of the removed family were attacked with small-pox, thus showing the value of having a house for isolating the members of a family in which small-pox has appeared. Three other cases were traceable to the lodging-house; one, the brother of the lodging-house keeper, who had been visiting him on Christmas day; and the other, a child who had not been vaccinated, and whose parents, tramps, had spent one or two nights at the lodging-house. These two cases occurred at Halifax. A third subject of the disease had found his way to York before the rash appeared. All the attacked recovered except a man who presented no signs of having been vaccinated. The others had all been vaccinated except one, the only one who recovered who had a dangerous attack and was disfigured. The infection of the lodging-house appears to have been derived from the landlady, who had been visiting an old soldier in the workhouse hospital at a time when there were cases of small-pox there.

It is clear that but for the energetic action of the authorities, small-pox would have broken out in many other parts of Bradford, and in neighbouring towns. The health of a town or district depends not only on its internal control by a spirited administration, but on the care with which neighbouring and even distant towns and counties attack disorders of which a chief characteristic is easy and subtle dissemination by human agency.

TETANUS.

Tetanus is a very remarkable and peculiar disease, for it occurs in a very large number of cases as a consequence of wounds or bruises, which may have been severe or slight, and occurs also in many cases without assignable cause,[1] attacking strong or weak, healthy or unhealthy; but it is not contagious or infectious in the

[1] Haydn's *Domestic Medicine.* By Edwin Lankester, F.R.S., and others.

ordinary sense ; recent experiments have proved it to be transmissible by inoculation in animals.

Symptoms of an attack begin usually between the fourth and tenth day after the injury has been received. When showing itself before the tenth day it is usually fatal. It mostly follows contused wounds involving nerves and the fibrous structures, fasciæ or tendons. Negroes and Asiatics are much more liable to attacks of tetanus than the white races.

Idiopathic tetanus seems often to be caused by exposure to cold and wet and by intestinal irritation. It is rare in England, but frequent in the tropics.

Brieger succeeded in isolating four alkaloids from pure cultivations of the bacillus which causes tetanus.[1] The first, tetanine (C_{13} H_{30} N_2 O_4), produces tetanus in animals. The second produces tremor, paralysis, and violent convulsions. A third produces convulsions. A fourth causes tetanus accompanied with a flow of saliva and tears. Therefore tetanus is most likely due to the above poisons manufactured by the tetanus bacillus producing its effects, after getting into the blood, through some selective action on certain parts of the motor nerve-centres.

The bacillus of tetanus is about 1 to 1·2 μ long. It produces spores, and inoculations in mice and rabbits reproduce the disease. It has been cultivated in blood serum. It is anaerobic.[2]

Tetanus is most common in Northern Italy, its maximum being in Lombardy and Emilia, where people frequently work in the hot season with bare feet. They are attacked in the proportion of one hundred males to thirty females.

[1] *Micro-organisms.* Griffiths. [2] *Ibid.*

Horses are subject to tetanus, owing probably to the collection of earth in their feet and their liability to wounds or bruises, in addition to natural susceptibility, *i. e.* inability of their blood-cells and serum to counteract the microbe and its poison.

Nicolaier discovered that certain kinds of soil introduced under the skin of animals give rise to tetanic symptoms.[1] A microbe from the pus of these animals inoculated into other animals, produced the same symptoms, but the cultivation was not perfectly pure. Kitasato, Tizzoni, and Cattani independently separated the organism described by Nicolaier. By an ingenious process, depending on the earlier attainment of spore-formation, Kitasato obtained the spores, and from them a pure cultivation.

The spores of tetanus bacillus have a remarkably wide distribution. Originally they were only cultivated from garden-soil, but they have since been gathered from the sweepings of a hay-loft, and the dust on harness, from the grime on a man's hand, and imperfectly cleansed surgical instruments. M. Bossano got positive results from soil from twenty-seven different parts of the globe, out of forty-three submitted to experiment. Soils which contained much organic matter almost invariably contained the tetanus bacillus. Failures to produce tetanus with pure cultivations are common, and the organism soon loses its virulence under cultivation.

Vaillard and Vincent found that spores injected alone could not set up tetanic symptoms, but that with other organisms such as those of lactic acid, or with lactic acid itself, or with bacillus prodigiosus, or with

[1] *Bacteria and their Products.* By Sims Woodhead, M.D.

their own poison, or into a bruised wound, tetanus was invariably set up. In these cases the tissue cells are so engaged in removing the foreign matter, or so paralyzed by the poison, that they are not able to contend on equal terms with the tetanus bacilli, which, under these favourable conditions, and removed from the action of oxygen, grow rapidly, and give rise to their special poison, to which the patient succumbs.

The tetanus bacillus is a facultative saprophyte. A horse, in stable or field, has sufficient earth about him to be easily inoculated; he, in turn, may inoculate a man by a kick with the sharp iron of his dirty shoe. Gardeners, field-labourers, and all who work with horses or on the soil, bear on their hands a virus which only needs a bruise or a cut, but especially the former, to allow of its setting up tetanus. Soldiers in campaigns, camping on the ground, and having their clothes, etc. soiled, are more liable to the disease than when accidentally hurt during times of peace. The poisoned arrows of some savage tribes are made deadly with a film of mud from the edge of a mangrove swamp. The spores on the arrow-heads become more and more attenuated in the course of months or years, and the savages well know the value of recently-dipped arrow-heads, on which we may suppose both the spores and the poison, with which they are associated as a product of the bacilli, to be virulent to a high degree.

M. Peyrand found the microbes of tetanus to be very numerous in the earth of a cellar.[1]

Tetanus is produced by the constant development in the wound of a special bacillus discovered, and described by Nicolaier in 1884, in the pus of animals

[1] *Les Virus.* Arloing. 1891.

rendered tetanic by the inoculation of pieces of earth.[1] Kitasato afterwards isolated the same organism from the pus of a tetanic man or of animals infected with earth, cultivated it in a state of purity, and showed that the inoculation of the cultures caused with certainty tetanus in different animals. The bacillus is anaerobic; it may be cultivated in most of the nutrient media, but beef or fowl broth are the most favourable soils; a temperature of 38°-39° C. is most favourable and proper for spore-producing. The spores are very resistant, will stand boiling for three to four minutes, and a temperature of 90° for two hours, 80° for six hours. Kept from the light the dried spores will be preserved active for months; but exposed to air and solar radiation they weaken or die in a few days.

"The pathogenic agent of tetanus is found only at the seat of the primary lesion." It is presumed that the bacillus secretes an active poison which becomes disseminated through the organism. Filtered cultures in broth, free from microbes, determine in animals as fatal tetanus as that produced by injection of living microbes.

A dose of one-thousandth of a cubic centimetre of artificially virulent poison kills a guinea-pig; a mouse is killed by a quantity represented in weight by ·00025 milligramme.

Neither the tetanus bacillus nor its spores multiply in the normal living body. But associated with various bacilli, as *prodigiosus*, or with their products, as with lactic acid, the tetanus bacillus appears to grow in the body, and the same effect is produced if a *bruised limb* is injected with tetanus spores. The probability appears

[1] *Public Health*, May 1891. From *Annales de l'Institut Pasteur*.

to be that anything which weakens the phagocyte-protecting cells of the blood allows the bacilli or their spores to develop, for the cells were found, in healthy blood, to devour and remove the spores of tetanus.

Dr. Behring[1] in a communication on diphtheria to a German medical paper, reiterates the statement, founded on experiments made in conjunction with Kitasato, that "mice by treatment with the blood of tetanus-immune rabbits are not alone protected from an attack, but even if several extremities have become tetanic, and death may be expected within a few hours, even then, if the blood be injected, recovery takes place with certainty, and so quickly, that in a few days no trace is left of the sickness." If these observations are correct, we may ask, why somewhat similar treatment has not been resorted to in the case of human beings dying of tetanus?

Dr. Kitasato found by experiment that—(1) The blood of the rabbit protected from tetanus has tetanus-destroying properties. (2) These properties are also in the extra-vascular blood, and are to be recognized in the cell-free serum. (3) These properties are of a permanent nature; they also act on the organism of other animals, so that transfusion of the blood or serum produces a therapeutic action. Dr. Kitasato believes that he has proved (and his experiments on mice, as given by him, are very satisfactory) that immunity is based upon the capability of the fluid parts of the blood to neutralize the toxic substance which the bacillus of tetanus produces.

Gamaleia found somewhat similar results[2] to the

[1] *Public Health,* February 1891.

[2] Mr. Hankin. *International Congress of Hygiene.* 1891.

above in the case of vibrio Metschnikovi, the poison produced by this microbe being destroyed by the blood serum of the rabbit, but not by that of the guinea-pig, these animals being by nature respectively "refractory" and "susceptible" to the attacks of the microbe. Mr. Hankin's experiments left little doubt that the bactericidal action of blood serum is due to the presence of substances which he calls "defensive proteids." He found that the serum of rats, which are known to be insusceptible to anthrax, contained a proteid body with an alkaline reaction, and that this, injected with virulent anthrax spores into mice, prevented the development of the disease. Young rats, which are liable to anthrax, may be protected by injection of the serum of the parent rat. Mr. Hankin proposes to call the defensive proteid that occurs naturally in a normal animal a "sozin," and that which occurs in an animal artificially immune a "phylaxin." The former acts on many kinds of microbes and their products, the latter on one kind. He does not exclude the action of phagocyte cells in destroying invading bacteria.

According to Emmerich, the blood and tissues of immune animals act remedially if injected subcutaneously.[1] Erysipelas and pneumonia are curable by the injection of the blood or tissue-juice of immune animals, soon after infection. Rabbits are protected against pneumonia by intravenous injection of a much-diluted culture of diplococci of immune rabbits. Professor Fodor concurred in thinking that an alkaline substance, more than phagocyte cells, is inimical to pathogenic bacteria.

The prevention of the occurrence of tetanus can

[1] *International Congress of Hygiene.* 1891.

scarcely be more than partial, for the microbe is extremely common in earth, and gains the power of infecting by means of bruises and wounds, which weaken the resisting power of the wounded part, and the poison is diffused through the body while the microbes increase locally. It seems possible that an antidotal poison may be discovered, or a germicide acting on the microbes introduced, but the subject attacked is often ignorant of any danger till actually seized. Injection of the blood of immune animals seems a hopeful remedy for the future.

Great cleanliness, avoidance of handling earth when the hands are bruised or wounded, and possibly immediate excision of any part into which known tetanic earth has been driven, are important. In Italy and other countries where people go barefoot, the prevalence of tetanus would be reduced by the use of sandals or boots. Horses' hoofs should be kept clean. Defective drainage and pollution of the surface of the soil, and rich organic earth, are, according to Bassano, elements of danger.

TYPHOID.

Typhoid Fever is caused by the introduction to the human body of a specific poison from without, bred in sewage and like matter, and carried usually by water or air. It is accepted on all hands that the typhoid poison is reproduced in the system during the fever, and the contagium is present in the intestinal discharges.[1] The fever does not appear to be communicable except by these, and their virulence or infective power, is, after the lapse of a short time, increased by warmth, stagnation, seclusion from the open air, and mixture with excretory matter, water, and milk. Though the disease is very seldom directly communicated from the patient to others, it may easily be conveyed through neglect of proper precautions in the removal of clothes, linen, carpets, etc., and want of cleanliness generally.

The usual vehicle of the poison is contaminated drinking-water. Heavy rainfall may reduce the prevalence of typhoid in a town, by flushing sewers, while it raises it in country villages, by washing surface filth or the contents of cesspools into wells. Wholesale dissemination of typhoid occurs through the distribution of milk from a farm, where a case of the disease exists, without sanitary precautions being taken to keep the milk and water from contamination. More common still, drain-pipes, sinks, and imperfect traps allow sewer-gas to enter a dwelling-house, and the poison probably enters the system by the lungs, or the waste-pipe of the cistern runs into the drains, and the drinking-water is poisoned. Offensive and evil-smelling open drains are much less likely to produce the disease than covered unventilated drains, which have access to the interior of the house. In the free atmosphere typhoid is rarely caught, even at an open cesspool.

The mode of entrance of typhoid is both by air and by water, the mode of propagation being chiefly through the intestinal discharges of persons sick with the disease.[2]

[1] Quain's Dictionary. Article by Dr. W. H. Broadbent.

[2] *Practical Hygiene.* Dr. E. Parkes.

The severe outbreak at Croydon, in 1852-3, was shown by Dr. Carpenter to be due to the pollution of water by cesspools; at Hastings, eight persons were attacked through the pipe of a closet being connected with the drinking-water cistern; at Munich, a severe outbreak at a convent was traced to polluted wells; at Bedford, water was likewise a cause; in some cases water which has absorbed sewer-gas is deadly; at Tottenham, Guildford, and other places water was shown, as early as 1866 and 1867, to be a probable cause. After a race-ball at Cowbridge, attended by about 100 persons, more than one-third were, within a short time, laid up by typhoid. Water was in this also the apparent cause. This case is instructive as showing that strong, healthy persons may be attacked in large proportion through a single dose of the infected water. Dr. Budd, Mr. Simon, Dr. Seaton, Dr. Thorne, and Dr. Buchanan all contributed valuable evidence establishing the propagation of typhoid by sewage and water. Dr. Sanderson showed that the tension of air in sewers is greater than that in houses, and it is now realized that the warm air and chimneys of houses often draw the air out of the sewers which poisons the inmates.

Many villages, Dr. Parkes observes, though very bad in drainage arrangements, are free from typhoid for a long time; when it comes it attacks large numbers of inhabitants. Clearly they were not protected by previous unrecognized attacks, or acclimatization. The introduction of the specific germs is necessary in addition to the filth in any locality. These sometimes pass from place to place in such secret ways that it is almost impossible to trace them.

The bacillus of typhoid was first accurately described and distinguished by Eberth, Klebs, and Coats.[1] "The bacillus can grow perfectly well both in the presence of free oxygen and also when oxygen is cut off; but, as in the case of the cholera organism, it appears to have somewhat different functions and different powers under the two sets of conditions; outside in the presence of oxygen it appears to develop great resistant power and a saprophytic habit, whilst in the anaerobic condition, especially in the intestine, although its power of breaking up the albuminoid substances presented to it and of developing its specific toxines is greatly increased, its capability of resisting antiseptic substances is considerably diminished. It grows characteristically on sterilized potatoes, and will also grow on other culture media, on milk and gelatine. It develops an acid, and not an alkaline, excretory product. Under certain conditions it develops easily outside the body; for instance, in milk and in water. The bacillus has been found in the body, in the dejecta, and in tainted water-supplies. Vigorous cultivations ensue from bacilli from fæces kept fifteen days in a sterilized tube. There is reason to believe that the intestine of man is prepared for the growth and entrance of the typhoid bacillus into the system by certain streptococci and septic organisms previously existing there, and that the bacillus may be swallowed with articles of food or drink. The action of light has been found so hostile to the typhoid bacillus, that growth only takes place slowly on substances exposed to diffused daylight, and in direct sunlight fluid cultures may be killed in from four to seven hours. The chemical rays of the solar spectrum appear to be especially hurtful to this organism, as in the case of certain chromogenic bacteria.

[1] *Bacteria and their Products.* Woodhead.

Fresh air and sunlight are shown by experiment to be powerful agents with which to combat this disease."

Investigations made by MM. Grancher and Deschamps led to the following conclusions.[1] The bacillus does not pass through the soil with irrigation water. It is stopped by twenty to forty centimetres thickness of soil. It retains its life for months amid all the organisms which soil contains. It does not penetrate into healthy vegetables.

Recent researches by MM. Rodet and Roux indicate that the bacillus of Eberth is the bacillus coli communis in a state of degeneration, and that this latter bacillus acquires outside the body its "typhigenic" character.[2]

Dr. Percy Frankland[3] has found, from a number of experiments with various bacilli of a pathogenic character, that they do not present any special uniformity in their behaviour in potable water, and that, therefore, it is highly misleading to apply the results which have been obtained with one organism to the case of another organism. Also, that most of the pathogenic organisms which have been hitherto experimented with, do not appear to have been capable of extensive multiplication in potable water, yet many of them are able to preserve their vitality in this medium for a considerable time—many days and weeks—and those which, like the bacillus anthracis, form spores, retain their vitality for practically an indefinite period of time. Gaffky's typhoid bacillus, although not multiplying in potable water, preserves its vitality for at least ten to fourteen days, even in distilled water.

With regard to disinfectants, Dr. Arthur Whitelegge[4]

[1] *Public Health*, June 1889.
[2] *Ibid.* April 1890.
[3] *Sanitary Record*, March 15, 1887.
[4] *Ibid.*

shows how much reason we have for distrusting the disinfectants commonly used and wrongly applied. The net result of the researches of Koch and Klein is that our ordinary chemical disinfectants as ordinarily used are no defence against spore-bearing germs such as those of anthrax. Mercuric chloride, however, is a striking exception, and a truly powerful germicide. Chlorine is useful, but can only disinfect freely-exposed surfaces; it is applicable to rooms. Boiling and disinfection by steam are much the safest and most efficient of all means of killing bacilli and their spores. In Nottingham this is carried out by the Sanitary Authorities free of charge.

Janowski found that a temperature of 55° C. was sufficient to kill the bacillus, if maintained for not less than ten minutes. There are several different kinds of bacillus greatly resembling the typhoid, which have been found in suspected water, but they are not quite so toxic, apparently, in their properties, when tested on mice. Cassedebat found that the typhoid bacillus could live at least forty-four days in distilled water, and seventeen days when in the presence of several other similar organisms.

During the twenty years preceding 1883, the average number of persons who died of typhoid fever in England was about 13,000 in each year.[1] Ten times that number have probably undergone the long illness without a fatal result. At Paris and St. Petersburg the proportion of sufferers from typhoid is much higher. Impure water is probably less pernicious in Paris than inhalations from sewers, cess-pits, *fosses permanentes*, and dirty unflushed soil-pipes. It may be said with almost

[1] *Trans. Sanit. Inst.* "Typhoid Fever," by J. F. Sutherland, M.D.

absolute certainty that the individual who contracts typhoid has been exposed to excremental pollution of air or water.

Mr. Sutherland has calculated that the loss to this country by typhoid fever, which affects so heavily the most efficient and productive part of the community, may be estimated for the twenty years 1861-80 at £23,300,000, and from all the filth-produced diseases at £29,500,000. (This last estimate seems comparatively too low.) The effect of sanitary works in diminishing the mortality from typhoid in certain towns is displayed by the following table—

Town.	Deaths per Million before Sanitary Works.	Deaths per Million after Sanitary Works.
Bristol	1000	650
Leicester	1460	770
Croydon	1500	350
Merthyr Tydvil	2100	860
Edinburgh	540	326
Glasgow	1240	435
Dantzig	700	74

The above are striking instances; but it may be said that, as a rule, where drainage and water-supply have both been well executed, there has been a very considerable reduction in the prevalence of this form of disease and death. Mr. Sutherland insists on the urgency of legislation to put an end, as far as possible, to the pollution of water and air, on which this disease depends. "The sanitary area must be enlarged by adopting the county, or combination of counties, as the unit area of administration; all future sanitary matters to be managed by a central authority composed of men duly qualified for the work." At present the common tale is, where typhoid has appeared, "drains with insufficient fall, joints open, work scamped, trapping arrangements defective, connection established between water and soil-pipes, ventilation of soil-pipes near bedroom windows." The primary inspection of pipes, joints, and traps would not be all. There must be periodical examination, and to carry this out the pipes, etc. must be laid in such a way as to admit of easy inspection.

Mr. MacGoun of Millport said that in all typhoid epidemics in country districts, he had found that the disease had its source in a well, into which ran the liquid from an adjacent dungstead. Frequently the water found its way into the milk, which in its turn reached towns and villages.

A very objectionable habit of building on the sites of rubbish-heaps, which were deposited on low ground, was described by Mr. Frew as prevailing in the little burghs around Glasgow. A similar process has been observed by the author in the outskirts of other large towns. The emanations from below the foundations of cottages built on such filthy sites must often give rise to obscure developments of fever.

Mr. Wallace Peggs[1] insists on the great importance of proper ventilation and flushing of any system of sewers and house-drains. Small openings are not even sufficient for the relief of pressure. The soil-pipe should be ventilated so as to prevent either undue pressure or the formation of a partial vacuum, which unseals traps. The true principle of ventilation for sewers and house-drains, is to have the foul air constantly replaced by the admission of fresh air. There must be no resting-place either for air or for sewage matters, in a well-constructed

[1] *Ventilation of Sewers and House-Drains.* By S. Wallace Peggs. *Trans. Sanit. Inst.* 1883-4.

system of sewers. Regular automatic flushing should take place once in every one or two days. The branches and terminal portions of sewers require the most attention. Sir Robert Rawlinson advises that ventilation should be provided for on all sewers at not more than a hundred yards from point to point, and if nuisance arises, then additional ventilation at shorter intervals.

A very common fault in the attempt to give some sort of ventilation to a drain, is to make the ventilating-pipe much too small, or to allow bends which are obstructive, or else to finish the ventilating-pipe close to a window or to a chimney-top. These half-hearted measures only replace one danger by another. The ventilation should be as free as possible, and, moreover, there should be sufficient flushing and ventilation in the drain to reduce the probability of anything noxious long remaining there. Circulation, and not stagnation, according to Sir Edwin Chadwick, should be the rule.

Measures of sanitation and general progress[1] have reduced the death-rate from typhoid fever in England and Wales, from 13,967 in 1869 to 6671 in 1885, or from 0·39 to 0·17 per 1000, while for simple continued fever the rate fell from 0·24 to 0·02. The rate for typhoid fever fell, after the execution of sanitary works, from $21\frac{1}{3}$ to $8\frac{2}{3}$ at Merthyr; from 15 to $5\frac{1}{2}$ at Croydon; from $10\frac{1}{2}$ to $4\frac{1}{2}$ at Ely; from 10 to $4\frac{1}{2}$ at Penrith; from $12\frac{1}{2}$ to 4 at Stratford.

"It had now come to be regarded as the result of etiological research, that the great potency of filth for mischief lay in the fact that it formed a nidus for the multiplication and spread of definite and specific contagia of disease."

[1] *The Progress of Preventive Medicine.* Dr. Thorne Thorne.

In 1858, Dr. Michael Taylor traced an outbreak of typhoid fever to milk, and in 1870, Dr. Ballard traced an epidemic of typhoid, at Islington, to a certain dairy, in which it was ascertained that water from a tank in direct communication with some old drains had been used for dairy purposes. Since this discovery, a large number of epidemics and cases of typhoid have been traced with the utmost certainty to the use of polluted milk. In 1873, Mr. Radcliffe and Mr. Power traced a wide-spread epidemic, in West London, to the use of milk from a dairy supplied with water containing excremental matter from a patient suffering from enteric fever immediately before and at the time of the outbreak. Cases have also been traced to the use of cream, and some have probably occurred through the use of impure ice and iced creams.

Some instances of the manner in which the infection occurs in milk so as to cause disastrous and fatal outbreaks may here be given, without the fuller details which may be found in the *Transactions of the Social Science Association* for 1883, in a paper contributed by Mr. Ernest Hart.

1. Case of typhoid imported from Liverpool. Children in cottage attacked. Milk carried into same apartment (kitchen), and mother nursing children milked cows. Milk distributed to customers from this cottage.

2. One hundred and seven cases. Well of farm in porous soil; dung-pit 5 yards from well; black sewage soaking into well. Dairyman ill of typhoid; virus probably washed from dung-pit into well. When the handle of the pump was chained up, the epidemic ceased.

3. Typhoid fever in farm. Ninety-three cases resulted from the use of milk, which was probably poisoned

by being exposed to the miasmata in the house, for the milk-cans were taken into the kitchen, next the sick-room, or by direct contact of unclean cloths with vessels. Unclean linen found alongside lids of cans.

4. Ninety-six cases from milk poisoned by access of typhoid-contaminated privy-contents to well, which appears to have been used by two milk-sellers, who both got their supplies of milk from the country. The way of infection here must have been through water or air to milk.

5. Sixty-nine cases. Water used for rinsing dangerous, being exposed to soakage of foul matter from privies and manure-heaps and from absorption of foul emanations from drains which communicated with pump-case.

6. Cows drank from cess-pools ; 68 cases.

7. Pump-well of milk-vendor's house within a few inches of an old, flat-bottomed, brick sewer, draining locality where cases of enteric fever had occurred; 63 cases.

8. Wife nursed dairyman, and continued milking cows, and washed linen at same sink at which milk-cans were cleansed. Husband, on recovering, nursed wife, and performed all the business of the dairy; 65 cases.

9. Farm-house depended for water on brook much fouled at this time by men engaged in building a mill 200 yards off. Large quantities of fæcal matter found on course of brook; 195 cases.

10. Well close to cesspool; 16 cases of typhoid had occurred on this farm within 20 years.

11. Case of typhoid came to farm. Cesspool 25 feet from well, and overflowing in all directions. Milk kept in the living-rooms; 131 cases.

12. Work of dairy carried on by persons who

attended to patients suffering from typhoid. Excreta thrown into channel on each side of central passage in byre. A deep well found by analysis very decidedly contaminated; 166 cases.

13. Well within a few feet of cesspit of common privy. Water proved unfit for drinking, and gave typhoid to two children who had passed by and drunk from it. Children at farm had been suffering from typhoid; 78 cases at least.

14. Cows milked near polluted stream, and cows' udders washed with water from it; 50 cases.

15. Bottom of well 3 feet below a pool of stagnant water, and still more below a dung-heap on which excreta of a typhoid patient (dairyman) were thrown. Soiled linen washed at dip-well. Suspicion that this water may have been used for scalding and other domestic purposes. This farm was one of thirty supplying milk to a Glasgow dairyman; nothing was found on others to excite suspicion; 508 cases.

16. Suspected sewer-air from inlet had free access to dairy and milk; 19 cases.

These may be taken as typical cases, and it is from defects such as these that many thousand maladies of the gravest character occur in England every year. The filthy farm-yard, the manure-heap on which excreta are thrown, the polluted surface from which multitudes of organisms are washed into wells, the percolation of sewage matter from cesspools into wells, the washing of dairy utensils with impure water, the attendance of the dairyman or dairywoman on typhoid patients, the placing of milk-cans in a kitchen or house near a case of typhoid, wiping vessels with cloths which have been exposed to contamination by foul water or air, a carelessness in the relations of house to dairy, water to cesspool, and milk to water; from these conditions a large crop of typhoid springs, and in this manner the fatality which falls on a town population often has its origin in the dirt of a farm in a distant county.

At country farms it is a common thing to see cows drinking from filthy pools, teeming with animal and vegetable life. It is not improbable that disease may sometimes arise from the milk of cows so watered, and there is obvious danger that after the cows have stood in specifically contaminated water the milk in the pails may receive infection. The mistals are often loosely paved, and allow of the accumulation of liquid manure in the ground underneath.

The milk is often kept in all kinds of out-of-the-way places, is exposed to dust and flies, and to emanations from drains, cesspools, or manure-heaps.

The officer to be appointed to look after the carrying out of any Act for the purpose of improving the condition of mistals, cow-houses, dairies, milk-shops, etc., should be appointed by a central local authority, such as a County Board, or a combination of delegates from sanitary authorities.[1]

In New South Wales, an epidemic of typhoid recently occurred through the pollution of a well supplying a dairy, the well water having been used for dairy purposes, and even for adding to the milk, although a public supply of water by meter was accessible.[2] This epidemic is worth noticing for the fact that the name of the offending dairy was mentioned over and over

[1] *Milk Supply.* By Thomas Britten, M.D. *Trans. Social Science Association*, 1883.

[2] *Lancet*, November 15, 1890.

again by the public authorities in connection with "disgusting" conditions affecting it. It is desirable that when very fatal results upon a population are produced by criminally careless farmers and milk-vendors, the names of offenders should not be concealed, as they usually are at present in England.

For the prevention of typhoid and other diseases having their origin in dairy farms, the following conditions are important—Purity of water-supply in all stages of its use; appliances for scalding vessels, etc. with hot water; a dairy separate from the house, and with an entry only from the open air, well lighted, drained, and ventilated; cowsheds in a wholesome condition, and farm-yards well kept, without stagnant pools or overflowing cesspools; and all these things subject to inspection by the local or county authority.

Dairy utensils, cans, cloths, etc. should never be taken into or left in living-rooms of dairy or milk-shop. They should be washed at a properly trapped sink used for no other purpose. They should be exposed in the open air, at a good distance from any untrapped sink, or manure-heap, ash-heap, privy, or other possible source of contamination.

If any case of infectious disease should occur at the dairy or the milk-shop, there must be absolutely no communication between the person milking the cow or attending to the dairy and the sufferer; and no person suffering from infectious illness, or recently in contact with any one so suffering, should be allowed to take any part in the dairy or in the distribution of milk. No washing of infected clothes should be carried on at a dairy farm.

The occurrence of any case of disease, whether believed to be infectious or not, should be reported, under a heavy penalty for neglect, to the Medical Officer of Health, within twelve hours of its occurrence at a dairy or milk-shop. In the event of the suspected spread of disease by means of a dealer's milk, he should be bound, under penalty, to furnish a list of his customers to the local authority.

The above contain the gist of the recommendations made by Mr. Hart at the meeting of the Social Science Association in 1883. Some of the principal measures there advocated have since that time been partially embodied in legislative enactments.

Dr. Corfield stated at a Conference in 1883,[1] that typhoid is sometimes contracted directly from foul air, and that Dr. Budd was of opinion that it could be conveyed by direct contagion through the medium of the air. Rarely, it may be caught from the emanations of a drain outside a house in the open air, but quite commonly from the foul air drawn from the drains into a house when the doors and windows are shut and fires lighted. When traps have not been used for some time, they get dry, and allow the passage of sewer-air into the house.

In London, typhoid is chiefly spread by the pollution of water by means of sewer-air containing the poison of the disease, which finds its way into the cisterns through overflow-pipes or waste-pipes connected with the drains or soil-pipes. The poison may be spread unconsciously in many places by some person who may go about for two or three weeks unconscious that he is affected by this disease. At a small fishing town in Cornwall a young man was brought home unwell to a house at the

[1] International Health Exhibition Conference.

upper end of the town. His illness proved to be typhoid. The midden-heaps and cesspools of the place generally drained into the stream from which drinking-water was drawn: in a short time typhoid was raging all over the town.

According to Dr. Budd, typhoid fever, "like malignant cholera, dysentery, yellow fever, and others that might be named, is one of an important group of diseases which *infect the ground*, hence the quasi-miasmatic character attached to them all, which has misled so many observers as to their true mode of spreading." Dr. Budd held most strongly the opinion, which was at first opposed to that of the majority of the medical profession, that typhoid and other contagious diseases do not arise *de novo*, but from specific germs, and from previous cases of the disease, the germs being scattered by air and water, and through the agency of men, animals, and insects.

Professor Tyndall, in a fine letter to *The Times*, dated Nov. 6, 1874, gave the strongest support to the theory of William Budd. The "special and almost peculiar *locus* of the disease is in the intestine." Referring to the epidemic at Over Darwen, Tyndall says, "for this period (fifteen to twenty-five days in each case) every individual smitten at Over Darwen has been flooding the undrained ground with the poison of this contagious fever. It reaches the drinking-water; it partially dries and floats in the air; it rises mechanically with the gases issuing from cesspools, and thus the pestilence wraps like an atmosphere the entire community. How could a disease whose characteristics are so severely demonstrable have ever been imagined to be non-contagious? How could such a doctrine be followed out, as it has been to the destruction of human life?" "The failure is mainly explained by the mischief often being done at a distance from the sick-room through the sewer," described by Budd as "a direct continuation of the diseased intestine." In November 1863, a girl suffering from typhoid was admitted to the Convent of the Good Shepherd, near Bristol. Fifty-six inmates were struck down within the next few months. Dr. Budd adopted the following measures (briefly put)—Flooding drains, immediate disinfection of discharges and of bed and body linen, ablution and disinfection of hands of nurses, burning or disinfection of all beds vacated. "It may be said that the plague was *instantly* stayed." Instances of typhoid development in villages are commented upon, which show very decisively that mere nursing of the typhoid patient, without the most stringent precautions, is often sufficient to communicate the disease.

Dr. Willoughby, commenting[1] on Mr. Woodhead's remarks as to the action of light on typhoid bacilli, said that this action explained the rarity of river pollution epidemics, for the bacillus, unlike the bacillus of cholera, would be killed in the course of the river. Dr. Murphy, however, cited instances of typhoid conveyed by polluted rivers, as that by which Gloucester suffered through the poisoning of the river by Kidderminster, twenty miles higher up. Dr. Pringle observed that an outbreak occurred in a Scottish town through the drawing back up the course of a river of contaminated water, resulting from a single case of typhoid. A weir prevented the rapid flow of the contents of the sewer, and the pump a little higher up drew the polluted water into the supply.

[1] *Epidemiological Society*, May 16, 1891.

Mr. Davies, M. O. H. of Bristol in 1875,[1] found from his experience that all water from wells situated in the midst of or near to human dwellings sooner or later become contaminated with human sewage, and that water drawn from such a source is the most dangerous and most constant means of diffusing the seeds of typhoid fever. The most eminent analysts may be unable to prove sewage contamination, but nevertheless water apparently pure has been the means of diffusing cholera and typhoid, having received contamination of small amount from patients suffering from those diseases. Mr. Davies considers typhoid to be under the control of measures at the command of sanitary authorities, and that therefore an inquest under a medical coroner should be held in case of death from this disease.

Dr. George Goldie of Leeds has found[2] from his experience that in large towns vacant land becomes the receptacle of rubbish, and sometimes worse material; in time cottage property is built upon this made soil. The offices to those houses are large, sunk in the ground, and open to rainfall; in short, the old ashpit system. "I have often observed and noted that scarlet and typhoid fever soon break out in such places, and it is in those advantageous quarters that they wage their fiercest and most protracted attacks." It is clear that deposits upon land likely to be used for building should be prevented by the local authorities, and land upon which such deposits are made should be *ipso facto* prohibited as building-ground. These sources of disease are most pernicious, for being under new houses, they are not likely to be easily destroyed, and they remain to inflict

[1] *Sanitary Record*, January 23, 1875.
[2] *Ibid.*

perennial suffering on a population otherwise perhaps in good sanitary circumstances.

M. Siredey, in a Report on Epidemics to the French Academy of Medicine, noted[1] that typhoid fever broke out in barracks at Guerot soon after a field near them had been covered with the soil from privies.

The naturally healthy village of Turner's Hill, Sussex, was subject in 1875 to a great deal of typhoid fever caused apparently by the close proximity of wells to cesspools.[2]

The effect of sanitary works on the death-rate from typhoid in the towns mentioned below is considerable.[3]

	Reduction of Typhoid Deaths per cent.		Reduction of Typhoid Deaths per cent.
Banbury ...	48	Merthyr ...	64
Cardiff ...	40	Newport ...	36
Croydon ...	63	Rugby ...	10
Dover ...	36	Salisbury ...	75
Ely	56	Warwick ...	52
Leicester ...	48	Cheltenham ...	30
Macclesfield ...	48		

In Munich the statistics for typhoid were as follows, the improvement being consequent on sanitation.[4] Modern sewers came into operation in the years 1880-84.

Typhoid deaths per 100,000—	1850-52 ...	242
,, ,, ,,	1860-67 ...	166
,, ,, ,,	1868-75 ...	127
,, ,, ,,	1877-79 ...	79
,, ,, ,,	1880-84 ...	22

At Breslau, similarly, the rate declined from 150 in 1863 to 60 in 1870, to 40 in 1880, and to 30 in 1882.

[1] *Sanitary Record*, January 15, 1886.
[2] *Ibid.* September 4, 1875.
[3] *Vital Statistics.* Newsholme.
[4] *Sanitary Record*, May 16, 1887.

At Tunbridge Wells, where the water-supply is pure, sewers are flushed, streets, etc. cleansed, and isolation hospital in use, the zymotic rate for the four years 1885-88 was very low, only 0·6 per 1000.

In Brussels, the death-rate has declined from 31 in 1865-71 to 23 in 1872-80, the water-carriage drainage system having now been in growing use about thirty years.

In Linz, the reduction has been from 42·9 to 32·73.

Dr. Hime has shown[1] that the typhoid fever rate for Bradford declined from 2·52 in 1874-79 to 1·88 in 1879-84. Bronchitis scarcely diminished at all, but pneumonia declined about 8 per cent., about the same amount as typhoid. This, with other considerations, tends to show that pneumonia is of a zymotic character, and partly, at least, reducible by sanitary measures, and especially by isolation, with precautions against bad air and infection.

Typhoid fever did not materially diminish in London during the twelve years ending in 1885, although typhus and simple continued fever greatly declined.[2] We must remember that as the drains get older the portions which may at some time have become infected with typhoid increase. And meanwhile the towns on the banks of the Thames and its tributaries increase in size, so that the chances of the London water-supply becoming polluted are multiplied. Last year a number of men who had drunk water from the Wey near Godalming were struck down with typhoid. The Wey runs into the Thames above the intake of the companies, so that the same water, largely diluted and filtered, is supplied for London use.

Where scavenging is defective, there must be a pro-

[1] Report of the Health of Bradford, with Retrospect of ten years.

[2] Longstaff's *Studies in Statistics.*

gressive contamination of the earth with noxious matter. Leaking sewers, drains, ashpits, and privies, all befoul the earth. Poisonous emanations then taint the wells, or where there are no wells, the air drawn from the earth through the basement area of houses into the rarefied air within brings noxious matter into the confined space.[1]

Mr. Thorp found[2] most of the cases of typhoid in his district to be due to a deficiency of water with which to flush the drains, and defectively-constructed w.c.s, sinks, etc. He also traced some cases to the use of water conveyed by a stone drain through fields, the water being contaminated by surface water which found its way into the supply.

A condition in towns which may account for some outbreaks of typhoid and other fevers is noted by Mr. Brown, M. O. H. for Carlisle, in his Report for 1884, as follows—The dwellings of the poor are generally situated in the narrow lanes or in confined courts, closed at the end, with the houses built back to back. The slaughter-houses are mostly situated separately in the above courts or lanes, and the accumulation of refuse is allowed to remain in open manure-pits or heaps, the liquid part finding its way off by the surface channel, or underground drains, or remaining in stagnant pools. It is quite common to find w.c.s and ashpits in close proximity to the slaughter-houses, and putrefying manure-heaps where blood and other refuse putrefy.

In 1873, in the Barnsley Rural District, and in many others, ill-constructed and offensive ashpits, open to

[1] *The House in Relation to Public Health.* By Dr. J. B. Russell, M. O. H. of Glasgow.

[2] Report to Todmorden Sanitary Authority. 1884.

catch the rain, and often half full of foul water, were almost universal, and there was no one to see that the owners kept them in tolerable order. The rate of mortality was high and increasing. Since that year drainage and scavenging have wrought much improvement, and the death-rate is greatly reduced.

Mr. Corner, in his Report for 1875 on Mile-End Old Town, referred specially to the production of disease in new houses built on ground used for years for the deposit of refuse of all kinds, these new houses themselves being occasionally constructed of materials from old infected houses.

The M. O. H. of Newcastle-on-Tyne referred some years ago to the baneful effects of building on made ground, which was practised there as elsewhere.[1] This town abounded in bad conditions, inside and outside the houses, which were fruitful sources of disease; among which clogged gratings, closets ventilating into houses, and partitioned in rooms, large pools of dirty water in yards, and walls in a horrible state of filth, were notorious.

In rural districts the causes of typhoid are very easily seen to arise mostly from the filthy surroundings of cottages and farms. "In very few parishes is the water-supply as abundant or as pure as it ought to be, and in parts of the parishes there is no water-supply good or bad."[2] Ponds, ditches, and streams, from which water is taken, are frequently polluted by privies placed over or near them, and are usually dry in summer, and filled in autumn with decaying vegetable matter. Shallow, unevenly laid, and leaky drains are especially common.

[1] *Sanitary Record*, February 15, 1884.

[2] *The Condition of the Mid-Warwickshire Sanitary Area for the year* 1874. By Dr. George Wilson.

With regard to overcrowding, "nothing short of imperial interference will effect any permanent improvement." The drainage of farmyards into villages, roads, streets, and water-courses should be reduced by insisting on the proper spouting of farm-buildings, and the construction of liquid manure-tanks, which should be water-tight, and hold the drainage from dungheap, pigsties, cowhouses, etc. When epidemic disease has broken out, Dr. Wilson thinks "quarantining" more efficient in villages than a hospital system. Sanitary authorities exercising an efficient quarantine over early cases would soon greatly diminish the amount of zymotic disease in the country.

An outbreak of typhoid among children in the Silsden District in February 1891, was traced by Dr. Atkinson to two original cases which had occurred in December. The excreta from these cases had been thrown in an ashpit.[1] On the 5th and 12th of January a quantity of decayed fruit, grapes, and oranges, had been deposited by a green-grocer upon the same ashpit. The fruit was discovered by the children who were associated as playmates, and distributed and eaten to a greater or less extent by all of them.

An outbreak of typhoid at Caius College, Cambridge, was traced to the accidental communication of water-pipes supplying closets with water-pipes supplying drinking-water, through the wrong placing of the valve. Most of those who drank this water were attacked by typhoid.

In an account[2] of an outbreak of typhoid at Carlisle, Mr. W. Brown, M. O. H., has shown that in his experience this disease was especially common and fatal in places where animal filth was present, viz. the neighbour-

[1] *Public Health*, April 1891.

[2] *Sanitary Record*, July 15, 1887.

hood of slaughter-houses, cowsheds, and dairy farms. And in the case specially investigated by him, the cows in a farm where the byres, etc. were excessively filthy, and where cases of typhoid had arisen, had for four years been suffering from a disease closely resembling the typhoid fever of man.

An outbreak at Shottery,[1] in 1876, was found by Mr. Fosbrooke to have had its origin in the use of water from a well contaminated with polluted water from a catch-pit only three feet from the mouth of the well. Liquid refuse from one of the cottages was thrown into this catch-pit and oozed through the soil and brickwork into the well.

A case of typhoid[2] is related by Mr. Hicks, M. O. H. of Easingwold, to have occurred through some pipes traversing the basement of the house being connected with the sewer. The defect was not at first discovered, and the patient was severely attacked a year later a second time before the cause was observed.

A wide-spread epidemic of typhoid[3] in Iron Mountain, Michigan, U. S. A., was investigated by Professor Vaughan, Director of the Laboratory of Hygiene. Part of the town was supplied with pure water; it escaped almost entirely. The water from many of the wells was bad. An open sewer ran through the town and discharged into a little lake, which furnished the ice-supply of the village. The disease was introduced by a railway-worker, who died of it; 350 cases followed. The bacillus of Eberth was found in the Iron Mountain water; it outlived some other bacilli with which it was at first associated.

[1] *Sanitary Record*, August 26, 1876.
[2] *Ibid.* August 19, 1876. [3] *Ibid.* February 15, 1888.

An outbreak at Poplar,[1] in 1888, was connected with the milk-supply, the dairy being ill-kept, and six of the dairyman's family having suffered from illness, he himself from typhoid. Other cases of diphtheria and typhoid were caused by a continuous supply of sewer-gas being laid on to the houses. The smoke-test in these defective drains was found very useful.

In the Report for Poole,[2] for 1889, it is noted that the only two fatal cases of typhoid were found on the same premises as cases of diphtheria.

Dr. H. D. Ward was led by the great increase of typhoid fever in his district to search for the cause.[3] He found it in the use of self-acting ball-hydrants, placed exactly opposite ash-pit doors, so that when the scavengers are at work the hydrants are frequently covered by the contents of the ash-pits, the liquid filth from which must drain into the hydrant boxes. "When the water is turned off at the top of the street, which happens now and then, the ball of the hydrant falls, allowing the filth to enter the main. The disease was most virulent near these hydrants."

A severe outbreak of typhoid in 1873, in Sheffield, was caused by a flood of the highly-polluted river Porter, which deluged the cellars and basements with sewage; 200 deaths were caused by typhoid following this flood.

A condition rather common in the country is the following, which existed some years ago in a Sussex village[4]—A row of eight cottages, in which low fever had existed without intermission for many months.

[1] *Sanitary Record*, January 15, 1890.
[2] *Ibid.* June 16, 1890.
[3] *Ibid.* January 15, 1887.
[4] *Ibid.* July 24, 1875.

Three privies at back of these cottages, on higher ground. Cesspools sometimes overflowed. Main drain from other cottages passes beneath this row, emitting foul smells from open gratings, and often overflowing. One tank through which this drain passed was within five feet of a well, which supplied eight families. Just below the village a stagnant pond received as much of the house-drainage as could reach it.

Mr. George Wilson maintains [1] that sanitary authorities in rural districts ought to have and to exercise power to enforce bye-laws, not only in respect to new houses, but in respect of the kind and situation of closets, and the proper construction and disconnection of drains. For want of this control most glaring errors are committed. Water-closets are erected with the cesspools into which they are intended to discharge often not far from the well; their appliances, etc. are faulty; the drains leaky, not disconnected or ventilated; the cistern supplying closets supplies also drinking water; if there be a bath, its water goes directly into the soil-pipe or drain. Water-supply should be from springs on higher ground. Villages obtaining such supplies are almost entirely free from typhoid fever.

Dr. Stevenson Macadam [2] has observed that bad water predisposes to attacks of illness, and that its action is marked in cases of diarrhœa, cholera, and typhoid. He had shut up many polluted wells in Fife, especially in 1866. One medical officer wrote to him that he had remarked that "deaths from cholera were chiefly, if not altogether, in the vicinity of these wells." Typhoid fever is almost coincident with cholera in its

[1] *Trans. of the Society of Medical Officers of Health*, 1883-4.
[2] *Edinburgh Health Lectures.*

preference for contaminated water, and the means which are adopted in preparation for cholera should be habitual for the prevention of typhoid.

Dr. Gauntt, of Burlington, U. S. A., finds[1] that typhoid, diarrhœa, and dysentery are frequent in that county, and attributes their presence to the habit of having the well in a shed, around which much washing is done, and where slops are often thrown.

Professor Brouardel wrote as follows in the *Revue d'Hygiène* in 1887—"I wish to demonstrate that the agents for the propagation of this disease are the water we drink, the air we breathe, soiled clothing, and the hands of attendants." Water he believes to be much more frequently the carrier of the infection than air.

Dr. Brabazon, M. O. H. for Bath, remarking[2] on the contamination of wells by surface drainage and manured areas, reported—"Were I asked in what direction sanitary efforts have produced the most beneficial and permanent results in the past year, I should say in the supply of pure water." The zymotic death-rates for the years 1871 to 1887 inclusive were as follows—2·2, 2·6, 1·4, 1·2, 0·9, 3·3, 2·1, 1·4, 1·5, 1·9, 0·9, 0·6, 0·8, 1·1, 0·5, 0·4, 0·3.

Bathwick Hill had formerly drained into cesspools, with the result that fever was almost chronic.

The unhealthiness of the town of Sheffield is largely due to the fact that the soil on which it stands is honey-combed with middens and permeated with noxious matter, "saturated with the sewage of generations," as the Medical Officer has expressed it in a full and excellent Report. The condition of the town has for

[1] *State Board of Health*, New Jersey, 1884.

[2] Annual Report, 1880.

many years been known to be disgustingly bad, and it has suffered from epidemics of great severity.[1]

Of the physicians of New Hampshire reporting cases of typhoid fever in their practice during the year 1888,[2] forty-two traced the source of one or more cases to drinking-water polluted by cesspools, sink-drains, privy vaults, etc.; seven reported cases under insanitary conditions generally; two found drainage conducted into cellars; two decaying vegetables in cellars; five had cases which resulted from contagion. One hundred physicians expressed their opinion that insanitary conditions are always present in cases of typhoid fever, either as the direct cause of the disease, or as a means of developing the germ or poison.

In one case the sink-drain discharged just under the window of a room where the milk and food were kept. Another case is remarkable as having been attributed by the doctor to the use of milk from a cow in which suppuration was going on. But by far the most common cause of typhoid appeared to be well-water polluted by neighbouring privies, by earth upon which slops had been cast, by manure-heaps, and other sources of contamination, which made for the bacillus of typhoid a suitable culture ground whenever the germs gained access.

Typhoid fever appears to be not infrequent among seafaring men of North America.[3] Coarse food, bad water, and foul air from ships' holds are credited with

[1] *Public Health*, March 1890.

[2] Eighth Annual Report of the State Board of Health, New Hampshire, U.S., 1889.

[3] Annual Report of the Supervising Surgeon of the Marine Hospital Service of the United States, 1874.

its production. The water is probably, in most instances, the true cause.

The Archdeacon of Gibraltar has called attention[1] to the large number of cases of typhoid fever, dysentery, and cholera caused by the failure to supply filters to ships, and urges this defect upon the notice of the Sailors' and Firemens' Union.

In 1873, Dr. Blaxall traced[2] an outbreak of typhoid at Sherborne to foul matters which gained an entrance to the water-mains during intermissions in the public water-service.

Dr. Thorne a little later traced a very severe and fatal epidemic at Lewes to a similar cause.

In 1879, 352 cases of typhoid at Caterham were caused by a man suffering from this disease having been employed in a deep well which supplied the town. Dr. Buchanan showed that in this case the water could not have contained so much as one grain of excremental matter in the gallon, yet this was sufficient to poison hundreds (and potentially probably thousands) of the population.

Dr. Blyth, M. O. H. for a district in Devonshire, ascribed an extensive outbreak of typhoid to overflows or leakages from overcharged drains, the wells being very full at the time.[3] He found that with early information, he could always prevent the disease from spreading.

The disposal of slops from cottages is always a difficulty in the country. Sir Douglas Galton mentioned

[1] See *Daily Chronicle*, Oct. 28, 1891.

[2] *Progress of Preventive Medicine in the Victorian Era.* By Dr. Thorne Thorne.

[3] *Sanitary Record*, February 15, 1876.

a convenient arrangement by which slops went into small carts on wheels, which were wheeled away every morning and their contents thrown on the land.[1]

Professor Fodor has given an account of an outbreak of 700 cases, followed after two and a half months by 300 cases, of typhoid in his district.[2] The town obtained its water from springs on the slopes of the mountain on which it was situated. After prolonged examination, five pure cultivations of the typhoid bacillus were made from this water. The character of the bacillus was confirmed by Löffler. It was found that the cause of the epidemic was a flow from leaky closets, belonging to the laundry of the hospital, into the water-supply of the town.

Dr. Schneider states that epidemics of typhoid in the French army are almost always traceable to the adulteration of drinking-water by fæcal matter; analyses made at the Val de Grâce laboratory prove this. Either the bacillus of Eberth, the bacterium of Cole, or an excessive abundance of the microbes of putrefaction have been found in the water which gave rise to typhoid outbreaks. Improvements in the water-supply have been undertaken and partially carried out, with the following results—Cases of typhoid in the army in 1887, 5991; in 1888, 4883; in 1889, 4274.

Brigade-Surgeon Staples showed how in India the young unseasoned troops were especially liable to typhoid, and recommended that they should land in the colder weather, and that the trench conservancy system, with accompanying well-pollution, should be altered.

[1] *Ibid.* Sept. 15, 1890.

[2] *International Congress of Hygiene*, 1891. Proceedings.

Brigade-Surgeon Maunsell found that though theoretically the system of conservancy may be good, practically it is very faulty; little or no dry earth is used, the receptacles and filth carts are broken and leaky, the trenches not attended to. The regulation distance of "within 300 yards" from barracks is too close. The trenches for bazaar people, coolies, etc., in the rains become simply quagmires of decomposing filth. The nullahs are often used by the natives with the worst results. The bazaars are overcrowded and insanitary. It is very important that a medical officer should have charge of the large stations.

Dr. Godfrey, of the United States Marine Hospital Service, stated that in cases of "typho-malarial" fever, all the patients had been found to be invaded by the bacillus of Eberth, and by the plasmodium of Laveran. In America those places are most exempt from typhoid which use river-water stored in upper-ground cisterns.

Professor H. Cayley said that one of the modes of spread of typhoid fever, cholera, and other diseases, was in the dust which at certain seasons blows up in clouds and contaminates air, food, and wells. In India the fields and open spaces are used as latrines. Typhoid prevails chiefly in the hot dry months before and after the rains.

Investigations made in Germany[1] have shown that in order that the water of a well may contain the least possible quantity of bacteria, the walls of the well must be of absolutely impermeable material; the well ought to be fed by deep subsoil water, and be in regular use.

The importance of carrying the coping above the

[1] *Zeitschrift für Hygiene,* and *Der Fortschritt,* July 5, 1886.

surface, and of keeping the surface clean, has been already noted, and corresponds with the precautions against cholera which are recommended for India.

A severe epidemic of typhoid at Mountain Ash, in Wales, was found by Mr. Spear to be owing to the water-main passing through a culvert containing a quantity of excessively foul sewage deposit, apparently including the drainage from a slaughter-house. The main was habitually at certain points in sewage-contaminated air. "Under various physical conditions very powerful insuction of external matters into a full-flowing water-pipe can take place." This is an important consideration in the laying of mains.

An outbreak of typhoid on board H. M. S. *Monarch*, at Gibraltar, in 1887, is instructive as showing the power of contaminated air alone to give the disease.[1] The ship was moored near the entrance into the sea of a main sewer. Very offensive smells were complained of as coming from this outfall, and borne by the wind. Four of those on board suffered from typhoid, and there were some cases among the men of the Rifles on guard in proximity to the offensive outfall.

Dr. Thursfield considers[2] that it may be accepted as an absolute fact that epidemics of typhoid and scarlet fever have been repeatedly disseminated by milk, and that there is very strong evidence that diphtheria has been so disseminated. "We have in milk a fluid specially suitable in composition and condition to afford a favourable seed-bed for the germs of infectious disease, supposing them to be capable of cultivation or develop-

[1] *Public Health*, February 1889.

[2] International Health Exhibition Conference. Dr. Thursfield on "Cows' Milk as a Vehicle of Infectious and Epidemic Diseases."

ment outside the human body." "Supposing freshly-drawn milk to be brought in contact with such germs through the medium of either air, water, or an individual infected in person or clothing, it is certain that the milk would not destroy these germs." "They would in all probability multiply at a very rapid rate. . . . Numerous instances have been recorded of the transference to man of the bovine foot-and-mouth disease through milk. . . . If there is one fact more than another which has been uniformly brought out in the records of milk epidemics, it is that the consumers of boiled milk have as a rule escaped, and the same fact has been noted in outbreaks of an American epizootic which is readily transmissible to man. Cream, which has been largely concerned in several outbreaks of typhoid, etc., may also be boiled without damage."

It should be incumbent on a retailer of milk to furnish a list of his customers. The premises on which the business of a milk purveyor is carried on should be registered with the local authority. Every registered dairy should be supplied with plentiful good water for dairy and cows. The dairy should not be subject to animal effluvia of any kind, and should be well drained, with no drain-end (unless disconnected) inside it. No milk should be transmitted for sale—(1) If presenting any marked deviation from ordinary appearances in colour, smell, or general condition. (2) If from an animal manifestly the subject of constitutional disease. (3) If from an animal suffering from acute or infectious disease of any kind. (4) If from an animal suffering from abscess, inflammation, or painful swelling, or other affection of the udder. (5) If from an animal not completely recovered from the febrile state, etc. of parturition. On symptoms of acute disease, or a large and sudden diminution of milk, the milk should be set aside. Any eruptive or infective disease in the person or family of any one employed about the cows or the dairy requires that the affected individuals be isolated and the fact notified to the health officer. In the case of throat illness occurring in several persons the same course should be followed.

Endemic fevers, in Dr. Thursfield's opinion, should never exist, and may be prevented. According to Professor de Chaumont, typhoid fever occurred every year at Eastney barracks, from 1864 to 1878. He was called in to investigate the cause after a fatal outbreak in 1878, and he found that the drain ran out into the sea and was frequently backed up by the tide, the foul air escaping into the barracks. This having been remedied, from 1878 to 1884 (the date of Professor de Chaumont's speech) there was not a single case of the fever.

Mr. Shirley Murphy (now Medical Officer for London) said there was no doubt a very strong presumption that boiling milk destroyed the germs of enteric and scarlet fever; this being so, householders ought always to boil their milk; this fact could not be too strongly pressed upon the public.

Professor Fleming said that a large number of dairies were not fit habitations for cows, nor was the milk supplied by the cows fit for human consumption. If laws were introduced to enforce sanitary arrangements, and better slaughter-houses were erected, a large proportion of the diseases now suffered by mankind would be abolished. Dairies ought to be visited regularly, and each animal should be inspected at stated intervals in order to ascertain its health.

Dr. Carpenter, in this connection, said that a great deal more trouble was taken to repress disease among animals than among men.

Dr. Russell, M. O. H. of Glasgow, has stated[1] that in the experience of that city ordinary chronic causes of typhoid fever, connected with defects of drainage, never produce contemporary crops over an extended area, but only erratic (sporadic) cases. Accordingly, an epidemic of typhoid, in 1880, was suspected by him to arise from milk infection, and was finally traced by him with great success, and with a full account of circumstances, to a very insanitary farm in the country, where typhoid had prevailed a fortnight previous to the outbreak in Glasgow. Diphtheria also had some years before affected several persons at this farm, the arrangements being such as to favour both diseases and their distribution to the people of Glasgow.

Professor Brown, of the Agricultural Department, Privy Council Office, has stated[2] that "nothing worse than the insanitary conditions of the average dairy cow can be imagined." The same description applies to the external and internal arrangements of many dairies and farmyards. "Dirty premises, diseased and dirty udders and teats, to say nothing of the state of the milkers' hands, are stern realities which may be seen by any one who is curious in such matters."

Milk, according to Dr. Louis Parkes, reflects to a great extent the state of health of the animal from which it is derived.[3] Cows are particularly prone to

[1] *Report on Certain Epidemic Outbreaks of Enteric Fever,* April, 1880.

[2] *Sanitary Requirements of a Dairy Farm.* By Dr. J. B. Russell.

[3] *Trans. Sanit. Inst. of Great Britain.* 1886-87.

take the infection of spreading diseases soon after calving. Milk has a remarkable power of absorbing gases and vapours, organic and inorganic, and is besides a fluid which possesses all the properties necessary to constitute it a suitable cultivating medium for low forms of life, fungoid or bacterial; so that specific disease germs which have gained access to milk may so grow and multiply that its powers of infection greatly increase with lapse of time.

With regard to typhoid fever, the most usual way in which milk becomes infectious is by the washing of milk-cans, etc. with water polluted by typhoid dejecta. Wells, ponds, and ditches tainted by the flow from privies or cesspools are the usual sources of such water. In other cases where the water was good, the milk has stood where emanations from a drain or from a sick person have reached it, or else the cans, perhaps just washed, have been inverted over a sink or untrapped grating.

The conditions and means of a wholesome water-supply, and the dangers to which water intended for drinking may be exposed, are described by Sir Douglas Galton.[1] Briefly, the main object must always be to obtain water from a pure source, not liable to pollution by cesspools, drains, cultivated land, or dirt on the surface of the ground; to prevent the possibility of contamination on its passage to the house or town; and to keep the pipes and cisterns in the dwelling completely separate from drainage, so that no air or gas from drains can infect it. These conditions are not observed in a very large number of houses in town and country, and consequently sporadic typhoid is still very common and

[1] *Healthy Dwellings.* Douglas Galton.

very fatal, though sanitary improvements in many districts have largely reduced its prevalence.

At Croydon, fever was found to prevail far more in wet than in dry seasons. This was attributed to the level of the water-supply rising in wet seasons so as to become tainted with the contents of cesspits and other sources of contamination on the surface of the ground. A shallow well should always be paved or cemented at the surface, and the paving should slope away from the mouth, so that no dirt may be washed into it. A shallow well should be puddled behind the steyning to the full depth, so that surface water should undergo filtration to the depth of the well before entering it.

Mr. Rogers Field, one of the first authorities on drainage, has summed up the sanitary principles which should govern house-drainage as follows—1. All refuse matter must be completely and rapidly removed from the house. 2. There must never be any passage of air from the drains or waste-pipes into the house. 3. There must be no connection between the drains and the domestic water-supply.

From an experience of eight or ten years, Mr. Field found that the majority of houses were very defective, and out of about a thousand he had examined, only three were sound.

The resident engineer of the Sanitary Protection Association stated[1] that total obstruction of drains had been discovered in 6 per cent. of cases examined; leaky soil-pipes in 31 per cent.; connection of sinks, baths, or fixed basins with the drain in 68 per cent.; and direct communication between the drinking-water cisterns and the drain or soil-pipe in 37 per cent. We

[1] *Sanitary Record*, November 15, 1884.

may here note that rats are a very common cause of introduction of sewer-gas, and that when this gas is evolved into the lower part of a house, it may be distributed to bed-rooms by the tubes of bell-wires.[1]

For every hundred houses inspected by the Edinburgh Sanitary Association, 90 per cent. had their drains in direct communication with the interior; 80 per cent. had faulty water-storage arrangements; and 15 per cent. actually had the main cisterns in direct connection with cesspools.

Among other recommendations, Mr. Hart considers that the following points should be provided for—The rural authorities should have the same powers as are now possessed by the urban. No new house should be allowed to be inhabited until passed and certified by a surveyor. Plumbers should be examined and licensed. Plumbing and drainage of all buildings should be executed in accordance with plans and specifications previously approved in writing by the Local Authority. No drainage work to be concealed until approved. The peppermint or other test to be applied.

The Local Government Board has recommended[2] that wherever there is prevalence or threatening of cholera, fever, diphtheria, or other epidemic disease (strictly this is the ordinary condition of most districts), sources of water-supply should be well examined. Water from sources which can in any way be tainted by animal or vegetable refuse ought no longer to be drunk. Water-pipes are liable to receive, by lateral induction at points of leakage, even when running full, external matters which may be dangerous. This fact is not sufficiently

[1] *Sanitary Record*, September 15, 1888.

[2] *Local Government Board Circular*, dated April 1888.

recognized. Where, unfortunately, there is reason to suspect any water, it should be boiled before being used for drinking, and not used for twenty-four hours after boiling. Ordinary filtering cannot be trusted. With regard to milk, it is desirable to boil it, as is always done in some continental countries. Ample ventilation should be enforced. Refuse matters should be speedily removed and destroyed. In enteric fever, the evacuations should be regarded as capable of communicating an infectious quality to any nightsoil with which they are mingled in privies, drains, or cesspools. They should not be thrown into any fixed receptacle, or where they can run or soak into sources of drinking-water. Dangerous filth may be mixed with powdered sulphate of iron (green copperas) before removal.

Quite recently the question of the development of typhoid has derived fresh light from the discovery of the bacillus of Eberth in cases of fatal fever in India considered as typhoid, so that the identity of the enteric fever of Europe and that of India may be taken as established. In India, young soldiers lately arrived from England are most susceptible to attack, and the disease appears to be growing more frequent. There is abundant evidence to show that it is very frequently attributable to the same causes in India as in England. It will be noted that the conditions of soil, air, and especially water, to which Europeans are exposed in India (as described under the heading of Malaria), are such as to give the disease very readily to young subjects accustomed to purer surroundings at home. And it is probable that the increased prevalence in India may be due to the gradual introduction of the bacillus to Indian soil and water, especially in the neighbourhood of cantonments. The careful cleansing of drains, cesspools, and of the surface of the earth in the neighbourhood of dwellings, the use of boiled water and milk, would probably prevent the development of most of the cases which are now looked for among British troops. The disease is frequent among soldiers who have been through an arduous campaign in a tropical country, on their return to England, and it appears probable that digestive disturbance consequent on change of climate may increase susceptibility.

In London, the maximum prevalence of typhoid takes place in October and November. It is likely therefore that the moderately high temperature of August and September is favourable to the development of the bacillus in drains and polluted wells. In India, the temperature may be very suitable, but possibly the presence of crowds of other bacilli in the worst native tanks may have prevented its growth in them, and it may find its best breeding-place in somewhat purer waters.

It is certain that the germs which produce typhoid may exist in water which neither sight, smell, taste, nor chemical analysis show to be contaminated, and that a very small leakage of infected matter from a cesspool or from the surface of the earth into a well of good water, may give such water deadly properties. It becomes therefore imperative to treat the excremental matter from cases of typhoid with the same care that is used in cholera; to disinfect with strong antiseptics or germicides, and to bury it far from dwellings and water-supplies; or, better still, to heat it beyond the boiling-point, or mix with ashes and burn it; it is dangerous to spread it in the soil near a house, or to allow it to pass down drains in the ordinary way, for the microbe is one that flourishes in dark damp places, and unless such drains are thoroughly and frequently flushed, a multiplication and extension of the mischief in the drainage system is likely to take place in favourable conditions.

The important points in every case of typhoid, in order to prevent a spread of the disease, are thus an early recognition, and consequent treatment, of infective matter from the sick-room, including articles of food and drink which have been standing in the room, with most scrupulous care by disinfection and removal from the house; to keep the drains free from any contamination from such matter; to recognize the origin and mediate carrier of the disease; and to take steps to cut off any further supply of the noxious element to the surrounding houses. There is good evidence that the specific bacillus does not usually arise *de novo;* but the ways in which it is distributed are so numerous, and so many typhoid bacilli may exist in the soil of inhabited places, derived from cases of the disease in past and less sanitary times, that it would be surprising if all outbreaks of typhoid could be accounted for. It is remarkable, indeed, how many cases it has been possible to trace to pre-existing cases, and to pollution of water by contamination with matter definitely derived from typhoid patients. There must very frequently be mild unrecognized cases of typhoid, as there are of all infectious maladies, of which the bacilli, finding their way by soil, water, or air, to new culture-grounds in drains, ditches, pools, manure-heaps, and wells, are competent to excite single outbreaks or epidemics without any history of importation or origin being obtained. It is on this account desirable to consider all pollution of drinking-water, water used in drains, and for cows, by excremental matter, as dangerous, because it may have so easily happened that the typhoid bacillus has gained access to this matter or has existed in it, and because water and milk, if so colonized by the microbe, are highly infective. As has been seen in diphtheria, if a mild unrecognized case of this disease comes into proximity to a susceptible constitution, or to one affected with sore throat, this person is likely to be attacked; so, in typhoid, a very mild case may start the infection in drains or water, and at a certain stage of development, temperature and perhaps some digestive disorder among the inmates of a house or population being favourable, an outbreak occurs in the house above the infected drain, or in the population supplied by the tainted water. But this is probably not the usual course of events. The water-supply or the drain, if by any means sufficiently infected either by recognized or unrecognized cases, or by an untraced transference of the germ, causes a proportion of those who drink the water or milk, or live over the drain, to be attacked with the fever, whatever their condition of health at the time. It is necessary to consider all as susceptible when the susceptible constitution is common, and its exact character unknown. At the same time, it may be well to remember that persons with disordered digestion, or overworked, or returning from a campaign in a hot climate, or, as in India, subjected to a sudden change of climate, are more susceptible than others. In all these cases, and when typhoid exists in proximity, the water and milk, if at all suspected, should be boiled, and care should be taken to avoid sewer and drain emanations.

But it is on communities and Local Boards that the real responsibility falls, and it is in them that the power lies, of making their district proof against frequent or wide-spreading development of this bacillus. Purity of water-supply, disconnection and flushing of drains, house-cisterns disconnected from drains, abolition of cesspools, where they can possibly affect wells used for drinking, prompt removal of refuse, regulation and inspection of dairies, and a complete knowledge of the condition of farms whence milk is supplied; these are indispensable requirements in any well-governed society.

In rural districts and villages where cottages have *sufficient* garden space, the privies should be so arranged that their contents may be easily, readily, and frequently mixed with earth or ashes and dug into the soil.[1] The pail system does not permit, if it is well looked after, of the accumulation of filth near dwellings. Where there is no sufficient garden space the landlord ought to make arrangements with some one to do the scavenging regularly, or provide some convenient place on which the householder might deposit refuse. Or the Sanitary Authority should undertake the scavenging by contract or otherwise. In districts where the provisions of the Public Health Act have been steadily carried out, the improvement in village cleanliness has been very marked, and has been accompanied by a gratifying reduction in the sick-rate and death-rate from filth diseases. In villages and scattered dwellings, where cesspools are not abolished, very careful attention should be given to making them water-tight and free from nuisance.

With regard to the disposal of slops and refuse-water, which now so often collect in noisome open drains near houses and roads, this must depend very much upon

[1] Dr. George Wilson, International Health Exhibition, 1884.

local conditions. The one essential is that they should be conveyed rapidly to a safe distance, and not accumulate in back gardens or by road-sides, or in any position where they may endanger the water-supply.

The condition of dairy-farms in the country is often excessively filthy, and a multitude of opportunities exist in them for the spread of infectious disease to the community, whether near or distant, which draws its milk from them. The cows are badly housed, crowded in ill-ventilated sheds, with dirty floors, and in the yard from which they step into their byre there is a reeking mass of manure and straw forming a huge culture-ground for pathogenic bacteria, wherever these are favoured by other conditions above the ordinary less harmful scavengers of the microbe kind. The cow itself may be affected with some ailment, which, transferred to man, becomes a serious malady. The farmer or milker may have an infectious disease in himself or his family, to which the milk is only too likely to be exposed. The emanations from straw-yard or sinks or drains are likely to reach the milk before it leaves the farm. The cans are often washed with water from a befouled well. When the milk reaches its destination it runs further risk of pollution by drains or infectious disease in an ill-situated and ill-ventilated milk-shop.

The ordinary straw-yard where manure collects and stagnates is an abuse which should never be allowed to exist. It belongs to the period when matted rushes on the bare earth rotting with the dirt of years was the flooring of English dwelling-houses. It is disgracefully wasteful, for much of the liquid manure is carried away by rain and much is lost in the soil below. The rain-water from roofs should be carried away separately, and liquid manure should run into tanks in a well-paved or asphalted yard. These tanks should be provided with pumps for the supply of the liquid manure cart, which would distribute this valuable material over the land. At present it wastes in the yard, and breeds microbes by the million, which inflict disease on animals and men.

Ill-health in cattle, in poultry, and in mankind is exceedingly common on such farms, and from them the seeds of mischief spread far and wide. The treatment of cattle and the condition of the farm-yard require thorough and sweeping reform. No dairy-farm should be permitted to dispose of milk or butter unless its surroundings are clean and its water-supply abundant, pure, and protected from liability to pollution.

If the County Authorities were to institute a periodical inspection of (1) wells in relation to cesspools, drains, and surface contamination; (2) drains and cesspools in relation to the air and salubrity of dwelling-houses; (3) scavenging arrangements; (4) farms and farm-yards, especially those which distribute milk or butter; and to regulate these matters in accordance with our present knowledge, typhoid fever would be reduced to a very low degree of prevalence within the regulated area. Already, well-managed districts rarely suffer from the disease except through cases imported from localities where these things are neglected.

TYPHUS.

TYPHUS FEVER is a disease chiefly of cold and temperate climates, appearing from time to time as an epidemic in towns and large villages, but very much more rarely than in former times.[1] An epidemic of typhus has often prevailed in towns for nearly three years. Those who have suffered from typhus are usually free from further attacks, but some persons seem to catch it as often as they are exposed to it. When typhus attacks a household, sometimes one or two of the number only suffer from slight febrile attacks, lasting for a short time. Typhus is highly contagious or infectious, and the incubation period is about a week. The contagion is certainly propagated through a short space of air; and is supposed not to be carried by clothes and excreta. Hence typhus may be greatly limited by securing abundance of fresh air, the patient being placed in a large room. Among the poorer classes, where people are closely crowded, these conditions are scarcely attained, and the disease rapidly spreads. Typhus is a disease of bad air, crowded towns, and crowded rooms, and it begins in the most crowded part of a town. It is rare in the country. Its greater prevalence in winter is due to the increased crowding and diminished ventilation at that season. As previous subjects of the disease are not

[1] Quain's Dictionary. Article "Typhus," by Dr. R. Beveridge.

commonly liable to a second attack, typhus necessarily tends to increase or become epidemic when a considerable number of persons have grown up without passing through it, provided other conditions are equal. Typhus is apt to attack famishing, ill-nourished, and poverty-stricken populations, but will also spread among well-to-do working people, if the essential condition of overcrowding be present. The improvement in the condition of the poor, and the greater cleanliness of dwellings, together with public sanitary measures, have caused typhus to diminish till it has become a rare disease, and indicative, unless merely caught by infection, of a state of overcrowding highly discreditable and dangerous.

Wherever typhus occurs, isolation of the sufferer in a large room or hospital is imperative, and it is important that all means of proper ventilation and avoidance of crowding should be adopted, with the object of preventing the spread of the disease in the overcrowded community.

According to Sir John Simon,[1] a well-ordered household may, quite exceptionally, receive the fatal contagion from some filthy hovel which has bred it; but, generally speaking, the contagion has little tendency to multiply itself, except where the same conditions exist as those under which it began. According to Dr. Watson, the specific exciting cause of continued fever cannot perhaps be utterly expelled or precluded; but when present in a community it may be rendered comparatively harmless by taking away the main conditions of its morbiferous efficacy and of its faculty of propagation. Every collection of medical experience, according to Sir J. Simon,

[1] *Sanitary State of the People of England.* Public Health Reports. Simon.

teems with instances to illustrate what are those main conditions on which the fatality of "fever" depends. The experience of common lodging-houses, single courts in a town, hospitals, workhouses, barracks, ships of the navy, prisons—all are to the same effect. Independently of famine, its ravages are everywhere connected with overcrowding and filth.

Typhus is essentially a disease of filth.[1] Where the unventilated atmosphere of habitually overcrowded places reeks with a stagnant steam from the breathing and sweating of its inhabitants—a steam which condenses in fœtid drops on window-panes, or soaks and rots in the papered or plastered walls; or where putrefying fæces are accumulated in cesspools or ill-conditioned drains, to taint the air or leak into the drinking-water of a population, there fever, typhus, typhoid, etc., tends to prevail in one or other of its forms.

The strong, and at the same time narrowly limited, infectiousness of typhus fever is shown well by the fact that when the London Fever Hospital and the Small-pox Hospital were in close proximity in the centre of a large field, all the doctors, matrons, porters, domestic servants, and nurses of the Fever Hospital were at some time attacked by fever (typhus), while no case occurred during eight years among the staff of the Small-pox Hospital.[2]

As late as 1780, Haslar Hospital received from the Channel Fleet 5539 cases of fever in the year. But not fifty years afterwards, the Vice-Admiral, Lord de

[1] *Sanitary State of the People of England.* Public Health Reports. Simon.

[2] Dr. Tweedie. *Cyclopædia of Practical Medicine.* Article, "Contagion."

Saumarez, was able to say that within his recollection the health of the navy had been doubled by improvements in its health-conditions. According to Sir G. Blane, fever had been greatly subdued by improvements in the method of promoting ventilation and cleanliness. The kind of atmosphere breathed may be inferred from Dr. Lind's statement—" I have known a thousand men confined together in one guard-ship, some hundreds of whom had neither a bed nor a change of linen."

The poison (or microbe) is of unknown origin, but communicates from person to person probably through the excretions of the skin and lungs floating in the air.[1] It is connected specially with overcrowding and debility from insufficient food. To prevent its spread, isolation, free ventilation, fumigation of infected places with sulphurous acid, heating (240° F.), and cleaning of all bedding and clothes, are important. Whenever practicable, treat patients in tents or wooden huts with badly joined walls. Fumigate tents, scrape and limewash huts, and remove earth from time to time from the floors. Patients should be treated separately, not aggregated.

Dr. Parkes points out that by the term isolation he implies the placing of the patient in a separate building. If a room must be chosen in the same building, a good room in the top story should be chosen.

According to Sir John Cormack, all the physicians who have had much to do with typhus, are of opinion that the attendants in typhus-wards run very little risk when the wards are spacious, well-ventilated, and not overcrowded.[2] " Such also is the opinion I have

[1] *Practical Hygiene.* Parkes.

[2] Sir John Rose Cormack, M.D. *Trans. Social Science Assoc.* 1880.

formed from my old personal observation of the disease in Edinburgh, and from all that I have subsequently seen and read of it." "The danger area is probably limited to eight or ten feet." The infective distance no doubt might be greater where the air is foul and close. In the Royal Infirmary of Edinburgh "the duties of the clinical assistants necessitated their being some hours daily in low-roofed, stuffy wards, packed closely with typhus patients." Nearly all the medical and clinical assistants who had to do with the fever-wards were attacked with the fever, and several nurses. Of the crowd of clinical students who passed through the fever-wards at the daily visit, only two or three took the fever, and among the students who only attended the general medical and surgical wards, it was said that no cases had occurred. "Well-ventilated depôts of typhus patients are not dangerous even to the attendants; in no degree dangerous to a neighbourhood by atmospheric communication, as is small-pox."

According to Howard, the philanthropist, who wrote in 1777, the malignity of the atmosphere of prisons was such that his clothes were in his first journeys so offensive that he could not bear the windows drawn up, and was therefore obliged to travel commonly on horseback. The leaves of his memorandum-book were so tainted that he could not use it till after spreading it for an hour or two before the fire. Vast numbers, to his certain knowledge, perished by the gaol-fever.

The keeping of criminals, observes Sir J. Simon, has been amended with due regard to sanitary requirements, and now, even if a single felon were known to die in England under circumstances which eighty-five years ago were the rule and habit of prison life, the whole strength of public opinion would express itself as against a murder. 'Yet outside that privileged area fever continues its ravages.' The same dark, close cell, the same damp floor, the same fœtid atmosphere, says Sir J. Simon, have to be again and again described by officers of health and parochial medical officers; no longer indeed as the scandals of prison discipline, but as constituting the too frequent household circumstances of the poor. Chiefly from among our labouring population fever takes its annual seventeen or eighteen thousand victims.[1] And besides the thousands whom it kills, there are many times the number whom it prostrates for weeks and months, and whom, with their families, it impoverishes or perhaps ruins and pauperizes.

Surgeon-Major Thomson proceeded in the early part of 1888 to certain villages in India where a fatal disease prevailed, which he found to be a severe form of typhus, highly contagious, and bred and fostered by filth.[2] The brunt of the attack was borne by a cluster of villages about 6000 feet above the sea. Nearly all those attacked died. Native opinion held the grain to be in fault, and instanced the undoubted fact that, previous to an outbreak, rats and mice and even snakes are found lying dead in numbers about the site, apparently poisoned. In this "puttee" the people, not having a ready market for their grain in good years, are in the habit of burying the surplus in shallow pits below the floor of their dwellings. "It is, however, to filth that I have no difficulty in attributing the disease."

Whether originating in such vile dens as these in

[1] This was written in 1858. The number has been very greatly reduced by improved hygiene.

[2] *Report on Sanitary Measures in India*, 1888-9.

Eastern villages, or whether cultivated in any part of the world where the same filth and overcrowding exist, there can be no doubt that typhus is the product of a microbe which finds its suitable breeding-ground in foul deposits and foul emanations. Walls and floors where many human beings congregate without sufficient ventilation and without domestic cleanliness, soon become coated with a condensation of filthy moisture upon which these minute scavengers can exist, probably by the million to the square inch, and from which they can issue to do their destructive work on the human body. Commonly, no doubt, such places are occupied by many other microbes; but where the appropriate conditions exist, where the air is foul and light insufficient, the particular microbe of typhus may settle and thrive. Probably there are many houses still in existence, the walls of which contain the materials and the organisms remaining from former epidemics or cases in sufficient quantity to multiply dangerously when the air and surfaces of the interior walls are long and badly polluted. Typhus thus arises where the air and dwelling are foul and unventilated. It spreads easily by infection from the breath or emanation from the sufferer. Judges and jury were often attacked after being exposed to the emanations of a prisoner who had been brought into court from his foul prison. But no disease yields more readily to ordinary care for a moderate degree of cleanliness and ventilation; and prevention of overcrowding and dirt in dwellings means prevention of typhus.

The disease has been commonly diminished by sanitary legislation and practice. But until overcrowding and filth are much further reduced, and until ventilation is much better observed (even to the reduction of packing and stuffing of people into railway-carriages, as on the underground-railways of London, where many thousands of persons travel daily in winter with windows closed, and ten, twelve, or fifteen to a compartment), it is not likely to be subdued altogether, or to fail by occasional severe outbreaks to disgrace the community in which these conditions exist. Ventilation and proper space everywhere will prevent typhus, and will also prevent that large class of diseases and ailments which depend on foul air and surroundings for their power of evil.

As in all infectious diseases, isolation should as a matter of course be strictly enforced, infected clothing and bedding burnt, and walls, if not pulled down, treated with the strongest antiseptic wash.

WHOOPING-COUGH.

Whooping-cough is a very fatal and widespread disease among children in England. Infectious particles thrown off by the cough, and carried to the air-passages of the susceptible, there fixing and multiplying, set up the same series of disturbances, reproducing abundantly the infectious material.[1] It occurs in epidemics, chiefly in the spring, and extends over towns or parts of towns or districts associated by various means of communication. It spreads so long as young children who have not had the disease before are

[1] Dr. W. Squire. Quain's Dictionary.

brought within its influence. The infection does not appear to be borne any long distance through the air. There are various predisposing conditions for the reception of the specific germ; teething, measles, and other illnesses seem to favour the infection. The incubation is from four days to ten days, or even a fortnight. Children who have been exposed to infection should not mix with others till three weeks have passed. After the disease is declared, the infectiveness lasts six or eight weeks; therefore children should be isolated for this period. The infection is a strong and persistent one; the air of the room occupied by the sick, the mucus thrown off by the cough, clothes of visitors to the sick-room, clothes of the convalescent, all readily propagate the disease. Infectious particles may cling to the clothing for a long time. Active infection is given off by those who are only slightly affected, or by those beginning to sicken, or by the insusceptible who have been with the sick, and are scarcely touched in the throat themselves.

According to Magnin and Sternberg[1] the bacillus of whooping-cough lives on the *epithelium*.

The disease is so common and infectious, that the great majority of adults have had it in childhood. Adults who have escaped it are not so liable apparently as children, and the danger, if they catch it, is absent.

It is clearly desirable that whooping-cough should be deferred from infancy to later years if it is to be caught at all. With this object great care should be exercised in the avoidance of any exposure to sources of infection, especially gatherings of young children among whom some may have lately recovered from

[1] *Bacteria:*

the disease. Children who have been exposed to infection should be excluded from school. The best isolation possible in infancy, thorough cleanness of room, clothes, and surroundings, are important. Whooping-cough is aggravated by insanitary conditions, a close and impure air, and the existence of more than one case in the same room. Exposure to cold, fatigue, and improper food, cause an accession of fever, and this increase is accompanied by an increase of the germs of disease given off, so that for the prevention of spread of the disease, as well as for the good of the patient, the best hygienic conditions are important.

Well-ventilated, clean rooms; absence of dust-collecting furniture, carpets, curtains, etc.; and plenty of space in houses and schools, with avoidance of any sort of crowding, are some of the first conditions for the diminution of this very destructive disease.

YELLOW FEVER.

Yellow Fever is a disease of cities and parts of cities, and is often localized, like cholera.[1] Its original and favourite seat is in the West Indies. It is connected with putrefying fæcal and animal matters. The localizing causes are connected with the accumulation of excreta round dwellings, and overcrowding. In the old West Indian barracks, which were often attacked, there were cesspits open to sun and air. The pre-

[1] Parkes. *Practical Hygiene.*

valence on board ship is easily explained; once imported, planks and cots get soaked with the discharges, which may even find their way into the hold or bilge. If this sort of thing happens in hospitals on shore, it is much more likely to occur on board ship, and the bad ventilation allows infection to spread.

To prevent yellow fever, the greatest care should be taken to prevent its introduction, either by the sick, or by persons who have left an infected place or ship. An infected ship cannot be considered safe until the cargo has been discharged, and the ship thoroughly disinfected and cleansed. The period of incubation of yellow fever is often fourteen to sixteen days. Any person attacked by the fever should be thoroughly isolated in a well-ventilated room, and all discharges disinfected and *separately* disposed of. If a house has been infected with yellow fever, every possible means should be taken to cleanse it before re-occupation; sewers should be thoroughly flushed, walls scraped, lime-washed, and fumigated with nitrous acid. The lowest story is the most subject to danger. On board ship cases should be treated in the open air on deck, and the vessel should be run for colder latitudes. Cleansing and fumigation with nitrous acid should be practised.

Nearly all the authorities who have seen it, agree that yellow fever is of a continuous type, and has nothing in common with the malarious intermittents.[1] Extreme filth and overcrowding is the cause of yellow fever. In Buenos Ayres, where a very severe epidemic took place, the streets are narrow and ill ventilated, and the foundations of some of the roads consist of

[1] *Dictionary of Hygiene.* Dr. Winter Blyth.

offal. The closets are excessively filthy, and the houses overcrowded. To prevent yellow fever, cleanliness, prompt removal of refuse, good drainage, ventilated houses, good water, and prevention of overcrowding are necessary. To arrest it when started, disinfection of all excreta, linen, mattresses, clothing, floors, and walls is important.

Yellow fever appears to have had its origin in the delta of the Mississippi, and has been spread by maritime commerce over the whole intertropical zone of the globe.[1] The centres of infection are always on the seaboard, often at the mouths of great rivers; hence it is supposed that the special microbe exists in its free state in the brackish marshes formed in their estuaries.

According to Griffiths,[2] the microbe (*streptococcus*) of yellow fever clings to the *ground*, and its diffusion may be barred by streams, walls, and, some say, by much-travelled thoroughfares. It does not appear to spread by means of city water-supplies. A certain saturation of the atmosphere is an essential condition for an epidemic. A humidity above 74° appears to be required, and epidemics cease when below 58°. Yellow fever is distributed, within small areas, by moist winds and human intercourse. The geological character of the soil is apparently unimportant. It is prevalent in the plains near the sea-coast. Vaccination for yellow fever is stated by Dr. Freire to reduce the mortality by nine-tenths, as shown by the results in 10,524 vaccinated persons. Further experience is required before this protection can be considered proved. Storms, heavy rains, and cold weather check the progress of yellow

[1] Trouessart. *Microbes, Ferments, and Moulds.*

[2] *Micro-organisms.*

fever. The period of incubation is variable; on an average it is from 20 to 100 hours, but is sometimes several weeks.

A micrococcus of 0·6 to 0·7μ has been found in the kidney, spleen, and liver in the course of yellow fever. These microbes form masses which greatly distend the blood-vessels.

Yellow fever appears to be capable of being conveyed a short distance up ravines by the wind.[1]

The process of Dr. Freire for attenuating and inoculating yellow fever microbes was reported upon by Dr. Girard, surgeon-in-chief to the Panama Canal Company, and Dr. Findlay of Havana, and the results obtained verified his method.[2]

The first trace of yellow fever is said by some to have been observed at the end of the fifteenth or beginning of the sixteenth century at San Domingo and Porto Rico; Columbus lost the greater number of his men within a year after landing at San Domingo.[3] In the seventeenth century it spread along the east coast of America as far as 8° south and 42° north, appearing for the first time in the United States at Boston in 1693. In the eighteenth century it appeared on the west coast of South America, and extended even to Europe and Madagascar, the great commercial and military activity of the time seeming to favour its spread, and increasing the frequency of epidemics, eighteen being recorded as having occurred in San Domingo during the century. At the beginning of

[1] *Healthy Houses.* Douglas Galton.

[2] *Sanitary Record,* January 15, 1890.

[3] Quain's Dictionary. Article, "Yellow Fever," by Dr. Joseph Jones, of Louisiana.

the present century it reached 47° north latitude in America, and prevailed in the Canary Islands, in Leghorn, and the maritime cities of Spain and Portugal. In 1853, 1867, 1873, and 1878, it spread to a large number of cities and villages in the interior of the American continent, being transported by ships and railroads. During this century it has been concentrated chiefly along the southern border of the Atlantic coast and Mexican Gulf. It has prevailed almost annually at Havana from April to December, and has been continuously endemic at Vera Cruz. It has visited several European ports, especially in Spain, Gibraltar, Lisbon, Leghorn, Rochefort. It is said not to appear in the East Indies or China. It has prevailed on the table-land of Caracas in Mexico at 3000 feet, and at Cuzco at 11,378 feet. The hills in Jamaica and San Domingo are free from the pestilence which rages in the low lands.

It never originates in country districts, but requires a certain density of population for its production, crowded cities on the shores of the ocean or of large rivers. Its origin and spread are favoured by the congregation of persons born in a cold climate, and where developed in strangers who have landed at a port where it is not prevailing, appears to be referable to the action of endemic causes upon highly susceptible individuals. However violent an epidemic may be, it ceases on the day on which the earth is frozen, but severe outbreaks have occurred at places like Cuzco, where the nights are cold and the days hot. The incubation period seems to vary in different epidemics, and in different individuals, from twenty-four hours to weeks or even months. In this respect yellow fever resembles malarious rather than infectious diseases.

Yellow fever almost always appears first in the lowest and most filthy quarter of a town, and in localities favourable to the production of miasmata. Heavy rains and cold weather check it. It appears simultaneously with bilious remittent fever. It is curiously selective in its area of prevalence; it seems to haunt seaports and shipping, and only slowly extends its boundaries, and does not affect the inhabitants of a roomy, salubrious locality.

The true method of propagation of yellow fever would seem to be this. The cause is a particular microbe, which thrives in tidal ways or mudbanks, or in the warm moist soil only slightly raised above sea-level, and especially where filth from human habitations is allowed to decompose. Possibly a brackish or slightly saline ground is best adapted to its growth. A certain temperature and moisture cause it to multiply and emanate from these situations in large quantities. The bulk of the indigenous population is unaffected, probably from three causes—(1) Selection, which has made them, the insusceptible, survivors; (2) natural acclimatization, or imperceptible vaccination; (3) a previous attack. Consequently, the microbe cannot often attack a population with great effect, unless many strangers be present, or many persons have grown up without having experienced the disease. The fever when once started spreads both by inhalation of the germs from the soil and by direct infection from case to case. The onset of yellow fever is signalized by "intense headache, rigors, pain in the limbs and back, rapid rise of temperature, eyes glistening and suffused, . . . nausea," etc. These are not unlike the well-known symptoms of an attack of influenza, which is probably in first origin a marsh-born microbe, and still more infectious. It is very necessary, however, in considering the origin and causes of various pestilential diseases, to consider less the symptoms than the habitat, manner of propagation, and conditions favourable to the growth of the disease. Thus, ordinary malarial fever may differ greatly from yellow fever and from influenza in the clinical aspect, but conditions largely similar may give rise to each, just as many different kinds of microbe may grow well on boiled potato.

There can be no doubt that such a condition as was described two years ago by United States Inspectors at a certain place in Florida is highly favourable to the growth of the pest. The streets were covered with decaying heaps of sawdust and garbage of every description, the drains were obstructed, the yards filled with garbage ; the site of the town was low and flat, with no effective drainage; and the surrounding pine forests were interspersed with a series of marshes and alluvial basins. In India the product would not be yellow fever, but malaria, which is in firm possession of the Eastern world.

The outbreak at Swansea in September 1865, was caused by the arrival of a vessel, the *Hecla*, from Cuba, with one of her seamen dying, and two others convalescent from the fever.[1] From Sept. 15, six days after her arrival, to Oct. 4, twenty persons of the town, in definite local relations to the ship, were attacked, also three of the crew of a small vessel which had been lying alongside the *Hecla*.

A more serious outbreak occurred in St. Nazaire, in France, in 1865. About June 13, the *Anne Marie*, a

[1] *Public Health Reports.* Sir John Simon. 1865.

wooden sailing vessel, loaded with cases of sugar, left Havannah, where yellow fever was epidemic; between July 2 and July 12 attacks of yellow fever occurred on board; on July 25 she arrived at St. Nazaire, where, "twenty days having elapsed since the last death, and thirteen days since the last case of illness," she was admitted to free pratique. On August 5 and 6, many of the labourers who had been unloading her fell ill with the fever; on August 1, the *Chastan*, which had been lying alongside the *Anne Marie*, but was now at Indret, had a first case, and by August 5 the whole crew of five men had been attacked; the place of the *Chastan* was taken by the *Dardanelles*, and the fever attacked the only person on board, a boy; the *Cormoran*, which had been taking cargo from the *Chastan* when alongside the *Anne Marie*, had, on returning to L'Orient, two of her crew attacked; another ship, a steamer, which had been in harbour near the *Anne Marie*, had two of her crew attacked; two lighters from Indret, which had been two days near the *Anne Marie*, had seven or eight cases of "a kind of half-yellow fever"; and an eighth vessel, the *Arequipa*, which had been for several days near the *Anne Marie*, had, on August 5, off the French coast, a first attack of yellow fever; this was followed by other cases.

It would appear from these, and from many other cases which occur persistently in the more congenial haunts of yellow fever, that the infective power of the microbe in favourable surroundings is a very high one; probably the organism grows readily when once planted in the moist hold and in the unventilated compartments of the ship, so that certain portions of the wooden surface would be found, if they could be examined with a strong microscope, to be covered with colonies of many thousands of millions of microbes, and articles of merchandise might similarly nourish plentiful crops in a close and hot atmosphere. At any rate, the results are consistent with such a view. And, like other disease-producing microbes, they yield quickly to influences of light and air, and lose their malignity where cleanliness and ventilation are the rule. It would seem not unlikely that in harbours, quays, and river-banks, or brackish tideways, the microbe may find its proper habitat, and that it may grow like lichen on moist wooden surfaces. The crowding and bad ventilation which are so common on board ship would favour its invasion of the human body. The importance of avoiding the reception on board of any goods which have been exposed to infection, of ventilating the hold of the ship as far as possible, and of isolating the labourers engaged in unloading a suspected ship, is obvious. It is best to consider even those who have been near an infected ship or person as possible vehicles of contagion until washed, brushed, and disinfected.

The yellow fever epidemic at Pensacola in 1874 was, like previous epidemics, the result of importation.[1] The Spanish bark *Virtuoso*, from Havana, was detained at the quarantine station, four miles distant from Pensacola, across the bay. A man who went into the hold and threw out ballast caught the fever. No other case followed in the city or hospital, though the fever continued at the quarantine station, until August. A German bark, the *Laura Maria*, entered port shortly after the *Virtuoso*, perfectly healthy. She subsequently

[1] Report by Surgeon-in-charge James S. Herron, M.D. *Report U. S. Marine Hospital Service*, 1874.

lost the greater part of her crew from yellow fever, having contracted it by being placed next to the *Virtuoso* in quarantine. Afterwards, three negroes who had been at the quarantine station came to the city, and one died of the fever. The American bark, *Elmira Combs*, was placed in quarantine (for Chagres fever) between the *Virtuoso* and *Laura Maria*, and a lighter came alongside from these ships. The crew of the *Elmira Combs* soon caught the fever, after they had been admitted to the city.

According to a resolution adopted by the Senate of the United States in 1874, yellow fever is almost uniformly introduced into the U. S. by seamen already infected with the contagion.

The Report of Dr. Reilly, Surgeon of the U. S. Marine Hospital Service, avers that—In the present state of human knowledge, to the same agencies only can we look for the prevention and control of this disease that we know are efficient, to a greater or less extent, in the control and limitation of the causes of other diseases, viz. small-pox, scarlet fever, typhus, enteric fever, consumption.

A number of cases appear to have been derived from mere proximity of vessels or houses to infected ships, and in one instance a vessel after undergoing disinfection gave the fever to a man who cleansed the cabin. The infection, according to Dr. Sternberg, seems to have been brought to Fort Barrancas in a barrel of potatoes from New Orleans. In another case, it attacked a young lady who had assisted at the opening of a trunk containing the clothing of a man who had died of malignant yellow fever some considerable time previously. Another very similar case occurred to a gentleman during frosty weather after opening a trunk of clothes worn by his deceased brother when attacked. When the yellow fever was introduced to any place by a traveller, it usually spread rapidly, unless the people, or, in the case of garrisons, the troops, were immediately removed to some distance and isolated. A very instructive case is related of the lasting quality of the infective matter. The clothes of a man sick of yellow fever at Milton, Florida, thirty miles above Pensacola, in September 1853, were packed in a trunk, which was locked up and stored in a warehouse, where it was covered with old sails and sacks. Two years later, in the summer of 1855, it was removed to Brooklin, Alabama, distant forty or forty-five miles north, and was opened in the house there, in the presence of several persons. Soon after, five or six of the inmates of this house sickened, and some of them died, of black vomit (yellow fever). In the summer of 1853, an infected blanket thrown overboard from the U. S. steamer *Vixen*, was used by a negro, who shortly afterwards died of the disease; the fever then spread from his quarters.

According to Surgeon G. N. Sternberg, the poison (organism) of yellow fever is portable in ships, goods, clothing, etc., and a minute quantity is capable of giving rise to an extensive epidemic. It may remain for an unknown length of time in a quiescent state, when not subjected to a freezing temperature, or exposed to the conditions necessary to its multiplication, and may again become active and increase indefinitely when these conditions prevail. According to Mr. Reilly's Report, it is quite practicable to prevent the importation of yellow fever, or to prevent epidemic manifestations. "In order to insure an effectual quarantine, the surgeon-in-charge should be an officer of the Army, Navy, or Marine-Hospital Service, the institution a Government one, and the occupant entirely removed from all political or local influences. . . . It may be further remarked, that the pay should be sufficiently liberal to command the services of efficient, competent, and incorruptible medical officers, and to make them independent of local influences." He considers the most effectual way of disinfecting a vessel to be by battening down her hatches, and subjecting her to a freezing temperature (30° F.) for three or four days, so that the bilge-water may remain frozen for that length of time. With regard to atmospheric spread, it was noted that in 1853 the troops at Barrancas did not contract the fever from the crowded hospital within 300 yards of them, but from a drunken soldier.

At Shreveport, the epidemic of 1873 was severe, so that many persons who had suffered in 1853, and even in 1867, were attacked. The medical testimony was uniform as to the condition of the town. Even in the midst of winter, the accumulated filth in the alleys of the city, which intersect the blocks, began to be offensive; spring came and passed, and there, untouched, lay the filth of many months, in the almost tropical sun of summer, in the very heart of the city. Stagnant water, rotten garbage, and animal excrement filled the gutters; the refuse of hotels and boarding-houses in every portion of the city ran out of the private sewers into the streets, and there rotted and contaminated the atmosphere; dead dogs, cats, and rats remained where they had fallen; the whole city was enveloped in disgusting odour.

The town of Mobile, which was in a good sanitary condition, was lightly attacked, but in certain places, notably a "dumping-ground" outside the city, where dead animals and the contents of privy-vaults are converted into commercial fertilizers, the cases were exceedingly malignant. Some persons caught the fever through mere association for a short time with sufferers.

Mr. Reilly came to the following conclusions concerning yellow fever—1. That in the Western hemisphere, certain poison-germs originate spontaneously in most if not in all the West India Islands, at least as far north as Nassau, New Providence. 2. That such germs, if not exposed to a temperature below 32° F., or to the chemical action of certain agents, may retain their morbific potency for an unknown period in the holds of vessels, in storehouses, clothing, bedding, in masses of decaying animal and vegetable matter, and in soil containing such matter; and that such potency may be rendered active under favourable conditions—to wit, atmospheric exposure, moisture, and a temperature of 70° to 80° F. 3. These germs have survived the winter climate as high as 30° N. latitude, under the conditions above recited, and have thus originated the disease exclusive of direct importation. 4. That from the foregoing conditions, viz. proximity and wide extent of original sources of the germs and their prolonged retention of morbific power, a quarantine of exclusion is impracticable and a quarantine of detention useless. 5. That immunity from yellow fever in the United States is attainable only through the most thorough sanitary measures, embracing—(1) The destruction of germs on shipboard, as well in the personal effects of passengers and crews, as in cargo, hold, and bilge; such destruction either by artificial frost (systems of Peteler and Strebe) or by chemical action; (2) the prompt isolation of each case as it appears, and the same treatment of possible germs from such cases, in bedding, etc., as above indicated; (3) a revolution in the sanitary conditions of water-side precincts, over which the Board of Health should have more complete authority than over other portions of the city.

It will thus be necessary for any community exposed to the importation of yellow fever to exercise strict control over the entry of suspected persons or things, to provide for isolation, to direct the cleansing of vessels, quays, etc., and to exercise special care over the deposit of refuse and sewage matter, to improve the low resorts of seaport towns, opening alleys and yards to light and ventilation, to prevent overcrowding, and to deprive the roads and quays of all organic matter and moisture in which the microbe might largely multiply. A very great deal will still depend, when all this is done, on the care with which imported cases and infected ships are put apart, and all sources of infection cleansed or burnt. Travellers from infected places should be for some time closely watched, and, if possible, subjected with bag and baggage to some simple process of disinfection, washing, and brushing.

Since the places of origin of yellow fever are not many, and the fever itself depends for its growth on insanitary conditions, it would seem worth some considerable expenditure to put these places into a more wholesome state, especially with the object of preventing the least contamination of streets, yards, and harbours, and of overcrowding in the neighbourhood of the docks or quays. The low lands in St. Thomas, San Domingo, etc., where the fever prevails almost continually, should be subjected to drainage and hygienic measures, as for malaria; and by vigorous sanitation there is reason to believe that the fever may be reduced almost to extinction, even in the few centres where it is strongly entrenched.

Dr. Wallridge, Medical Inspector of British Guiana, states that yellow fever is not endemic there, "except so long as we keep up a supply of cases by the fresh importation of the germ, and so long as we preserve its favourite habitats."[1] The arrival of a susceptible newcomer causes a fresh outburst in the infected localities. Efforts have been strenuously made to exclude the disease during the last few years, and Georgetown has been quite free from it during 1889, 1890, and 1891 (so far). The three most favourite habitats of the germ are the bilges of wooden ships, tidal mud of a tropical river, and cesspits sunk in the alluvial soil of a tropical town. Coal, timber, and sugar vessels have bilges which especially favour its growth, and it is found that watertight, close bilges are much more dangerous than the bilges of leaky ships. The infection of yellow fever is sometimes very strong and rapid. A sailor visited an infected ship only for a few minutes, and was soon struck down with a fatal attack. An overseer paid a short visit to the room of an infected friend in Georgetown, and he too was speedily and fatally attacked. The measures of prevention recommended are—

Isolation. Destruction or disinfection of infected articles. Suspected vessels to be carefully dealt with by Sanitary Authorities. Cesspits to be disinfected, or, what is much better, abolished. After disinfection of

[1] *Lancet*, Nov. 7, 1891. From article in *British Guiana Medical Journal*, by Dr. J. S. Wallridge.

cesspits cases have occurred, but not one case has occurred where the pail-system has been adopted and properly carried out.

Further notes on yellow fever will be found in the Addenda at the end of the volume.

CERTAIN FEBRILE OUTBREAKS NOT CLASSIFIED.

New Febrile Malady at Aberdeen.—A serious outbreak of fever at Aberdeen in 1882 was caused by a bacillus, resembling the bacillus anthracis, supplied with milk to which water had been added. Over 300 cases occurred, all supplied from the same dairy. Three died. Recovery was slow. Experiments on rats showed that these died equally whether supplied with the milk, or else with the pus from the abscesses of patients, and the spores and bacilli in the milk were similar to those in the pus. Cultivations became gradually less active, and finally innocuous. When kept at a temperature which prevented spore formation, the virulence was attenuated and ultimately disappeared.

Dr. Russell, of Glasgow, has given in a pamphlet published in 1888 an account of a febrile disease which attacked St. Mary's Industrial Schools in that city in 1888.

He sums up to the following effect—That the outbreak in March 1888, was in its nature a febrile disease, tending to implication of the lungs, and especially to pneumonia. "It seems identical with a disease which has been observed in other similar institutions, more or less detailed accounts of which will be found at the end of this Report, in all of which the observers had a difficulty in assigning it a place in nosology; but in all of which it was associated with insanitary conditions of the nature of aërial contamination." "The *post-mortem* appearances pointed to a specific poison allied to that of enteric fever." "The experience of the Fever Hospital is strongly suggestive of a causal affinity between certain forms of pneumonia and enteric fever. The two diseases are frequently confused, both in their diagnosis and local incidence. This observation, as well as the present epidemic, raised a strong suspicion that we must enlarge our conceptions of the morbid manifestations which are to be regarded as proof of the influence of air contaminated with organic effluvia. If so we can no longer hold that the absence of enteric fever warrants us in concluding that known impurity of the air from sewage emanations, for example, is innocuous. The prevalence of acute pulmonary disease may be the result." Summing up the results of this investigation, we find that the St. Mary's Industrial Schools are situated in a densely-populated district of the city; that they are inclosed by surrounding tenements and other large buildings, along with a graveyard which was in 1875 described as "greatly overcrowded with bodies, and kept in a state of rank disorder," and in which have since been interred 577 bodies; that the free space attached to both, and available for exercise, is small; "that the internal air-space in both is deficient; that the inmates are children between five and fifteen years of age, who are the waifs of a large city, weak in constitution, etc.;" . . . "that the proportion of the total deaths caused by pulmonary diseases is enormous, and higher than among children of the same age in the worst district in Glasgow;" that in the words of the Government Inspector, "Contagious or infectious disease is constantly at their doors," and especially, that "there have been repeated epidemics of typhus fever." . . . "In the course of the outbreak the patients of Belvidere were seen by several eminent professional friends at my request." Professor Gairdner was inclined to regard them as cases of "influenza of a malignant type"; Dr. Finlayson had no doubt that they were examples of what has been called "epidemic or infectious pneumonia." Dr. Gemmell, in a detailed report, gives no name to the disease, which he says was allied to the acute specific fevers.

The overcrowded state of the school, the occasional use of the burial-ground for exercise, the very bad drainage faults, by which a highly-polluted soil, and drains kept warm by waste steam, gave out emanations into the wall of the school-room, seem to have afforded very favourable opportunities for this outbreak.

Dr. Russell cites the case of the East Sheen Boys' School, and other similar recorded outbreaks, as giving support to his contention.

The outbreak at the Birkdale Roman Catholic Reformatory, Southport, appears to have been similar, and to have had among possible causative circumstances, overcrowding in the school-room (200 boys two hours before going to bed; air stifling, hot, and fœtid), and distribution of solid and liquid excreta on the farm.

A febrile outbreak at Ansty, near Garvin, of the same sort, apparently, is attributed by Dr. Garvin to the filth of Ansty. He called it "sewage fever." [1]

[1] *Edinburgh Medical Journal*, June 1886.

The following account[1] of an outbreak at a Roman Catholic Poor Boys' School near London, has a special interest—

Disease caused by Inadequate Distribution of Sewage.—"At a recent meeting of the Clinical Society, Dr. Seaton gave a full account of an outbreak of epidemic illness which he had observed in a school or orphanage containing some 600 children, not far from London, during last summer. There were 157 cases of the disease, which were strictly confined to the school, and did not spread to the few cottages and houses in the immediate vicinity. The disease began in June, and lasted until September, and it caused seven deaths. The severer cases occurred early in the epidemic; and there were five cases of second attacks, not relapses. The outset of the disease was sudden, without any premonitory symptoms; the attack commenced with rigors and severe frontal headache, followed in a few hours by pyrexia, vomiting (often very severe), without diarrhœa, scantiness of urine, and almost complete absence of the chlorides therefrom. There was rapid development of the crisis, defervescence occurring in mild cases in two or three days, and in four or five days in severe cases. The fatal cases generally terminated within twenty-four hours from the commencement of the symptoms. At the time of defervescence there was a sudden fall of temperature, which was usually simultaneous with the appearance of a herpetic eruption on the upper lip, and perspiration. Earache and otorrhœa in some cases followed, and there was generally an absence of other local pains. The rapid rise of temperature at the onset was a constant feature of the illness. In mild cases it rose to 101° F. only, whilst in the very severe cases, more than half of the whole number, it ranged from 103° to 106° F. Pneumonia often supervened, and then the duration of

[1] From the *Sanitary Record* for December 15th, 1885.

the illness was *pro tanto* prolonged. Dr. Bridges thought that pneumonia was present in a large proportion of the cases, but was sometimes abortive. After death patches of congestion were found in the ileum and gastric mucous membrane. Dr. Seaton thought the malady non-contagious, and that its incubation-period was short. None of the adults, including masters, nurses, etc., in the establishment, about twenty in number, were attacked; and the boys over ten suffered much more than those under that age. An explanation of these facts was given by Dr. Bridges, who said that the school was a very unhygienic institution. The land attached to it was only six acres in extent, and the disposal of the large amount of sewage formed was always a difficulty, the earth-closet system having to be adopted. This had been in use for twenty years; and as all the refuse had to be distributed over the small area of land available—at most, an acre and a half—the ground was necessarily overcharged with fæcal matter. Four years ago two or three cases of a similar nature to the recent outbreak occurred, and one death. Poisoning was suspected, and ascribed to the unwholesome surroundings. An improvement in the closets then ensued, and the health of the school improved also; so that, until the present epidemic, but one suspicious case had been observed; this, occurring last year, was attributed to sunstroke. The water-supply of the school was very unwholesome and impure, and it was of course suggested that the epidemic was one of typhoid. Its characters, however, were quite unlike those presented by an outbreak of this disease which occurred a few miles away from the school. He attributed the affection to exhalations from the sewage-sodden land, on which the elder boys were put to work, and to which the younger ones were not required to go, thus explaining the remarkable immunity enjoyed by the latter, as also by the boys confined to the infirmary. The disease occurred principally from the end of June to the middle of September, during which time only a fourth part of the normal rainfall was recorded. This circumstance might have influenced the outbreak. Dr. T. Stevenson examined the contents of the stomach of the boy who died suddenly during the slight outbreak in 1879; and he and Mr. Bond concluded that death was caused by asthenia, due to sewer-gas. There seemed, from some further discussion which occurred, to be no evidence to show that any sewage contaminated with the excreta from enteric fever, diphtheria, or other infectious illness had been distributed over the school-land. Thus the matter for the present stands, almost an isolated series of observations. If other facts, which may confirm or confute the theory broached by Dr. Bridges, should come within the ken of sanitarians, it is much to be desired that accounts of the same may be published. In the present day, when the difficulty in the way of disposal of sewage and refuse, by the old-fashioned channels of sewers and rivers, is becoming continually greater, the earth-closet system and other similar methods for the disposal of fæcal accumulations are receiving extensive adoption. If, therefore, as Dr. Seaton's cases suggest, this system is not harmless to the public health, increased proof of the allegation is not likely to be long withheld; but, until such further demonstration is produced, it will be fair as well as wiser to retain one's opinion as to the correctness of the explanation put forward by Dr. Bridges, to whom as well as to Dr. Seaton thanks are due for giving this subject the prominence that it has obtained."

The resemblance to influenza in several of these outbreaks, and the resemblance of the Australian shearing-shed fever to influenza (*see* Dr. Parsons' Report on Influenza), lead to the suspicion that all these diseases are apt to arise in certain special conditions of overcrowding, combined with emanations from filth; such conditions in fact as existed in great perfection in Bokhara in May 1889. Once transplanted to the human organism, the microbe adapts itself to the new medium, and grows sufficiently virulent to be known as an infectious disease or epidemic.

It would appear as if there must be a variety of organisms capable of producing diseases of this kind, and as if the character of the disease induced, and its infectivity, depends largely on the particular type and virulence of the microbe. It seems to be pretty clear that the great pandemic which first appeared at Bokhara in 1889 was of a milder type, but much more infectious, than some of the febrile outbreaks noticed above, and much milder than its later developments which affected so many countries in 1891 and 1892.

Many circumstances in connection with the spread of influenza in 1890 appeared to amount to sufficiently strong evidence to justify the following conclusions:[1] That influenza is extremely infectious through confined air. That a large number of persons are highly susceptible. That the high degree of receptivity and infectivity has the effect of masking these very properties. That proximity to actual cases accounts for most attacks, infected articles for the remainder. That the microbes or their spores are exceedingly minute, probably hardly discoverable by the microscope, and that millions may emanate from a case in one day. That the rate of spread is accounted for by these qualities and by the short incubation period.

Further notes on the character of influenza and similar diseases will be found on pages 472 and 487.

[1] *The Spread of Influenza*, by R. Russell. 1891.

NOTES AND OBSERVATIONS.

SUSCEPTIBILITY.

Favourable condition of the body for the attack and growth of certain Micro-organisms.—The fact is notorious, and has been illustrated in the foregoing pages, that several diseases of great severity attack individuals and populations whose health has been greatly reduced below the normal standard. Thus, after floods and famines in India and elsewhere, cholera, malaria, dysentery, and other fatal maladies rage with violence; and in Europe and other parts of the world typhus, typhoid, pneumonia, and other diseases attend a low condition of the people—semi-starvation, and the overcrowding which is an accompaniment of distress. Typhus especially attacks populations reduced by famine, as was terribly exemplified in the Irish famine of 1846-47. Soldiers fatigued by long marches or exhausting campaigns are also much more liable to be attacked by fever, consumption, and dysentery.

Mr. Watson Cheyne believed, from experiments made,[1] "that in certain disordered states of the system, micro-organisms were not immediately destroyed in the body as in the healthy state, but could live for some

[1] International Medical Congress, 1881.

time, and if an acute inflammation were the cause of this disordered state, the micro-organisms might enter the products of inflammation and develop there, thus being accidentally present in and not the cause of an abscess."

"An irritant might be introduced subcutaneously, and cause an abscess in which micrococci were found without being introduced from without; micrococci taken from aseptic wounds and some abscesses, and growing in some infusions, might be injected in large quantities without causing abscesses, and even when more hurtful, a large quantity had to be employed in order to produce an abscess." "He, however, thought that even this harmless form might under certain circumstances cause an abscess, and in proof of this he instanced the case of a man in a very weak state of health, who got an abscess whenever he got a bruise, and in whose abscesses micrococci were present."

Dr. George Harley found by clinical and pathological data, that all disease-germs produce local lesions as well as constitutional effects; that local lesions are of two perfectly distinct kinds: (*a*) at the seat of the germs' introduction when they enter by contagion or inoculation; (*b*) in various parts of the body when they enter as just stated, or by the channels of infection. Both the local lesions and the constitutional changes are the direct effect of the chemical changes produced in the tissues and fluids of the body by the natural growth and multiplication of the germs in them, at the expense of the tissues and fluids of the host.

The question whether any of the common zymotic diseases arise *de novo* either in the body or in substances outside the body has practically ceased to be an open one. Although the possibility of a perfectly fresh development of a species of living germ hurtful to the life of man must not be left altogether out of view, yet practically we must no more expect the appearance of a case of scarlet fever, or small-pox, or tuberculosis, without exposure to pre-existing germs of the same kind, than expect the development of fantail pigeons in a dovecot independently of the previous existence of pigeons of a similar kind. But, on the other hand, it is quite possible that certain conditions may admit of the development of harmful from harmless bacteria, and indeed such transformations have been artificially produced. Microbes of specific diseases have been rendered virulent or non-virulent by passage through different kinds of animals, by desiccation, by heating, by cultivation in various fluids. These organisms multiply with great rapidity, so that a few days represent scores of generations. Most of them seem to preserve their weakened or strengthened state, so that they may, when artificially reduced, serve for the purpose of vaccination. But there does not appear to be much ground for expecting a production of vaccinal matter sufficiently safe, serviceable, and protective, for general use as a defence against the majority of ordinary infectious maladies. The use which may in future be made of attenuated microbes of various diseases would probably be best confined to vaccination with the particular protective virus at times and places subject to a threatening of the disease, just as at present postmen and policemen are re-vaccinated at the commencement of an outbreak of small-pox, and persons bitten by mad dogs are inoculated with weak virus even after they are bitten. But since we know the causes and natural cultivation-grounds of zymotic diseases, and the means of preventing their spread, by far the most desirable means of immunity will be to guard against their development by attention to those details which are important for the general health and efficiency, apart from the more serious and fatal pests. Cleanliness, pure water, and pure air are good for other reasons than their effectual preservation of communities from pestilence and death.

As sound health, proper nourishment, and cleanliness are required in the individual for more than protection against marked disease, so the clean and wholesome condition of a town or district avails for its progress towards an orderly and prosperous state, with tranquillity, mental energy, and uninterrupted development in the highest pursuits of human life.

The reasons why some persons exposed to the virus of disease escape, while others equally exposed succumb, are various. Let us consider some of the most common infectious diseases—those which infect by the air-passages. Thin-walled capillary vessels come very near to the surface of the body in many parts, and if these capillaries are distended with blood, their walls are rendered still thinner, and their contents come still nearer to the surface. The capillaries of parts of the mucous membranes of the nose, mouth, fauces, and conjunctiva, even in a state of perfect health, are covered with a very thin layer of protective epithelium, while those of the air-cells of the lung are practically bare. Through these, minute germs might readily pass. In many morbid states, the epithelial covering of the mucous membranes named is very soft, and any foreign particles would easily become embedded in it. In such a material, some kind of germs would find a suitable nidus, and at the same time, probably, soluble substances adapted for their nutrition. Minute offsets from these, as they multiply, would make their way to the surface of the capillary walls, and when the capillaries are much stretched, the germs or microbes might in parts penetrate into them, just as blood-corpuscles frequently make their way *out* of the capillaries to the surface; a cold bath, for instance, is with some persons occasionally followed by a slight escape of blood from the throat. Moreover, it is not at all improbable that some infective microbes behave like those which have been noted as attacking plants, and on the surface elaborate a substance which softens or deadens the tissue so as to allow invasion of the part beneath. Some certainly appear to produce a poison which paralyzes or weakens the action of the corpuscles of the blood, or else the fluid of the blood, which would otherwise successfully operate in resisting the invading microbe. The particular state described, soft, moist, mucous surfaces, dilated capillaries, with weak flaccid walls, is one which favours the passage of living germs into the body or growth upon the congested surface, and it is also a state which is practically known frequently to precede an attack of infectious disease.

A low condition of health is observed to be favourable to the attack of infectious illness, both because it is likely that the mucous surface and capillaries are in the state described above, and because the phagocytes and defensive proteids are less vigorous and capable of resisting the assaults which are in populous places always being made upon the body and blood by germs of disease.

"Particles of scarlatina contagium (*e. g.*) are caught on the tonsils, or inhaled into the bronchi, or swallowed, penetrate the mucous membrance, and effect inoculation.[1] We know that in the cases of gonorrhœa and ophthalmia, a particle of the blennorrhagic contagium on the natural surface is sufficient to inoculate, and it does not seem necessary, in the case of many infections, that the surface should be torn or wounded."

Of persons equally exposed to severe cold, which, by chilling the general surface, produces contraction of the *cutaneous* capillaries and consequent *internal* congestion, some do not suffer in any way, some are attacked by bronchitis, some by pneumonia, some by apoplexy, some by gastro-intestinal disturbance, some by jaundice, some by gout, and so on, according to the part of the body which the congestion most affects in each individual.[2] It is clear that the morbid condition of the body induced, and the congested area itself, offer opportunities of attack to various pathogenic microbes which are never very far off, and often lodged in ambush in the system.

Predisposition may be hereditary or acquired, and may obviously depend on several peculiarities, such as the character and ingredients of the blood, including the cells; the tendency, or otherwise, to congestion; the character of the epithelium; the taste for certain foods and drinks by which the blood is modified or organs damaged; a weakness of digestion, or of the liver; and various habits of life.

Dr. W. B. Carpenter, in 1853, had come to the conclusion that the common condition which all those

[1] Sir John Simon. (Quain's Dictionary.)

[2] See Quain's Dictionary, "Predisposition," by Dr. W. B. Carpenter.

agencies tend to produce, which experience has shown to be specially favourable to the development of zymotic disease, is this:—The presence in the blood of an *excess* of those decomposing effete matters, with which the circulating current is normally charged to a limited amount, during their passage from the parts of the body in which they are poured into it to the excretory organs by which they are cast forth. If decomposing matters be abnormally introduced from without, or be generated in abnormal amount within the body, or if the process of elimination be obstructed, an accumulation of these matters takes place in the blood, and this, by providing the pabulum requisite for the development of the poison, supplies the very condition necessary for its morbific activity. The liability of the puerperal state and of the condition following severe injuries to the reception and growth of specific diseases is thus due to the products of waste of muscular substance in the blood-current. Excessive exertion, a potent predisposing cause, produces waste of tissues and the charging of the blood-current with the products of disintegration. In hot climates, where the activity of the respiratory process is reduced by the high temperature, long marches are noted as causing special liability to zymotic infection. This obstructed elimination is also a pernicious result of overcrowding, and it is well known how overcrowding increases the prevalence of zymotic disease. In the inquiry into the conditions of the insanitary area of Bethnal Green, and in the evidence before the Royal Commission on the Housing of the Poor, it appeared that the death-rate in the worst overcrowded places is about double that in the better parts of the same district.

In 1846, the troops at Kurrachee were attacked by cholera: one portion located in airy barracks had lately had a long and fatiguing march, the death-rate was 96·6 per 1000; another portion had not been on the march, but was overcrowded in ill-ventilated tents, the death-rate was 108·6 per 1000; another portion had both been on the march and was overcrowded like the last, the death-rate was 218 per 1000. Dr. Madden has noted that trismus nascentium, a disease of infants, and spasmodic croup are very largely reduced by ventilation or removal to country air.

Intemperance in alcoholic drink is a strong predisposing cause of disease, especially in hot climates. A certain regiment, largely consisting of total abstainers, performed in 1846-7 a march of 400 or 500 miles in a very wet and unhealthy season through a country infested with fever and cholera, and was afterwards quartered in overcrowded barracks at Secunderabad; it escaped with a very unusually and remarkably small mortality, and there are many similar instances.[1]

Famine produces an accumulation of waste products in the blood, and is likewise noted as highly favourable to the development of fatal fevers.

Thus, in Dr. Carpenter's view, we seem furnished with a scientific rationale for all that experience has taught us as to the conditions of spread of zymotic disease.

But there are zymotics which attack the strongest and healthiest persons quite as successfully as the feeble, and here the probability is that in some cases the microbes are introduced in very large quantities (cf. case of Algerian sheep, which usually resist anthrax), and overcome the resistant powers of the epithelium and blood, and that in other victims the microbes find a

[1] See Parkes' *Hygiene*; also Statements by Lord Wolseley, etc.

nidus and pabulum on which they specially thrive. The fact that one person breathes through the mouth, another through the nose, the condition of the surface on which the microbe is deposited, the cleanliness or otherwise of the oral cavity, the acidity or alkalinity of the blood at the time of exposure, the presence of some minute qualifying substance in the blood, which may be food or poison to the microbe, the action of the cilia in pushing out foreign matter, or the inefficient action of the cilia, which may have been produced by some previous disease, the rapidity of circulation of blood at the time, the purity of the air breathed, are each probably factors in the infection or escape of persons exposed to the attack of infectious matter. It is known, for instance, that the condition of the body or blood following on recovery from certain epidemic diseases is favourable to infection by another kind of microbe. This is in some cases due to lesion of surfaces, in some to inefficient elimination, in some to the presence of some minute adjuvant poison, or to the absence of a defensive proteid. Again, the first beginnings of a cold may be successfully combatted by a large dose of ammonia or sal-volatile. The reason of this may be twofold: first, the relief and loosening of congested capillary vessels, and secondly, the presence of alkaline matter in the blood being unfavourable to the growth of a catarrhal microbe on the throat or within the mucous membrane of the air-passages. For reasons given above, the congestion of blood-vessels, say in throat or intestines, is favourable to the growth and invasion of pathogenic microbes. A very interesting experiment of Mr. Garrod[1] may be here noted. When the clothes are removed and the surface of the body

[1] *Proceedings of the Royal Society*, No. 112, 1869.

chilled, the cutaneous arteries are caused to contract. The blood is thus diverted from the external surface of the body to internal parts so quickly and decidedly that its temperature rises in the axilla to a point 2° F. higher than before the clothes were removed. The rise does not take place when the temperature is above 70°, and increases as the temperature of the air is less. It is easy to understand how colds, sore throats, malaria, dysentery, and other diseases may result from a chill, and be kept off by warm clothing and exercise, for we see that external cold causes congestion of capillaries, and we know that in many places a multitude of the microbes producing these diseases is frequently being brought into contact with the inner surface of the body, and that they can obtain an entrance or a feeding-ground, by the congested blood-vessels, which in a normal state is denied them. A temperature between 30° and 40° F. appears to be very favourable to colds, bronchitis, etc., and the reason may possibly be the chilliness at this temperature, without the bracing frictional action of a frosty air, and in conjunction with this chilliness a degree of humidity, and consequently of conductivity, greater than that at lower temperatures. Moreover, the cold is not sufficient to render inert the numerous microbes pervading the air of populous countries or places, nor to prevent their detachment from the surface of the earth.

It is likely that in the case of some infectious diseases, some persons, who do not catch the disease to which they are exposed, have unconsciously at some previous time had a very mild attack, which has been competent to protect them. We know that many persons have unconsciously passed through a slight attack of phthisis and have recovered; that many cattle have had pleuro-pneumonia unperceived; that scarlet fever, measles, whooping-cough, and diphtheria may be imperceptibly mild; and probably abortive attacks of cholera and even small-pox do occur.

Differences in susceptibility were very clearly marked in the epidemic of influenza in 1889 and 1890. As this disease had not been known for a long period, cases of previous attack may be altogether excluded from consideration. It is remarkable, that of persons exposed to a moderate degree of infection, or, otherwise stated, to a moderately large number of microbes, about the same proportion caught influenza as would have suffered from some of our common zymotics if exposed to them for the first time. The number may be taken as about one-third, and this is given by experienced doctors as the proportion of children attacked by measles to which they have been moderately exposed at school. In the influenza, interesting cases occurred of medical men who only caught the disease after having been many times exposed to infection. The majority, however, were down with it early in the epidemic. The cases of late prostration may have been due to at least two reasons: fatigue when exposed, and an excess of the microbic dose. But there were other rare cases of persons who had passed through a great deal of exposure to the disease, and who only caught it long afterwards. Possibly these cases may have been due to the retention of the germs in clothes which had been packed or put away, and to these germs only taking effect when the subject was vulnerable through a common cold or other cause of depression, or alteration of blood.

It has been observed above that congestion of the throat, etc., following exposure to external cold is favourable for the development of sore throat, catarrh, etc. It may perhaps be worth noting that congestion of the throat by other means, say irritating or scalding fluid, is also capable, in impure or marshy air, of giving rise to a specific sore throat. With some persons, acid foods or drinks, such as sour grapes, sour wine, and champagne, are capable of exciting sore throat. Sour grapes have a particularly marked effect. Possibly the mould or germs on the skin of the grape may contain particles capable of setting up a cold, if the favourably acid mucous surface or acid blood removes the natural alkalinity which otherwise prevents their growth. Or else there are present in the air-passages certain kinds of organisms which are enabled by the presence of an acid medium to attack successfully the mucous surface, and slightly poison the blood.

There can be no question at all that very small differences in the blood-quality are sufficient to determine infection or immunity. Even inoculations with considerable quantities of virus are successful with some animals and unsuccessful with others of the same species. And animals so similar in constitution, habits, etc., as rats and mice, are quite different in their reception of some kinds of virulent microbes. The most important constituents of the blood for protection are apparently the defensive proteids. Acidity favours infection of some kinds, and alkalinity favours infection of other kinds. Some poisons, such as that of the jequirity, strongly aid the infective power of certain microbic diseases.

Immunity appears to depend sometimes not upon insusceptibility to the microbe, but to the poison evolved by it, so that it multiplies and dies unnoticed in the body.

Hay-fever, which one would expect to attack all alike, since it is caused apparently by pollen-grains, selects its victims and leaves others wholly unaffected. Labourers and workmen are less subject to it than more delicately nurtured people. The inducing cause appears to be actual surface irritation by the particles, and not any parasitic growth in the body, for the complaint subsides on removal to town or sea.

From the considerations above brought forward, and further detailed in other parts of this volume, it results that immunity is best promoted by cleanliness, by proper nutrition of the body, a healthy condition of the blood, and by all measures which prevent internal congestion, in addition to any special means which have been proved counteractive to each kind of infective microbe. Vaccination is at present the great defence against small-pox, and probably something of the same kind will be found useful against other diseases. But in the long run the most satisfactory means of prevention will be the education of every member of the community to the highest condition of bodily health, the removal of outside media for the growth and retention of disease germs, and the isolation, under strict and uniform regulations, of every person attacked.

We must not cherish the delusion that either among men or animals the healthy escape. The most perfect health attainable will not save from some kinds of pestilence, if introduced, and consequently we must endeavour, while promoting the physical well-being of each member of the community, to extinguish and annihilate the source of disease, which, for the most part, comes to us from marshy land, decaying organic matter, filthy soil, filthy farms, polluted rivers and wells, stuffy habitations, and vitiated, confined, and over-breathed air.

Action of Microbes on the Body.—Without going deeply into an extremely complicated and difficult subject, the action of microbes on the body, the conditions of immunity, and the modes of infection, may be very shortly stated, in general terms, to be in many of the infectious or contagious diseases somewhat as follows—

Specific germs are breathed in or swallowed, or may occasionally enter by the conjunctiva of the eyes, or by the nose. A certain time is required for the growth and development of the germs at the point of inoculation, and thence the poison manufactured permeates with the blood to other parts of the body (as in diphtheria); or the virus travels from the point of inoculation to the lymphatic vessels and ganglia, thence to the general circulation. This is the period of invasion. The time between infection and illness is due in the first place to the time taken by the microbe to penetrate to its appropriate nidus; secondly, to the time occupied by multiplication [1] up to an amount capable of causing sensations of illness by the quantity of poison evolved; thirdly, to the resistant action of fluids and leucocytes in the blood, by which probably many individual germs are killed, and only the strongest survive; fourthly, to anatomical differences in the ganglia of different persons. The period of incubation also depends, as experiments have

[1] *Aspergillus niger*, a mould fungus, grows on damp bread, linen, etc., develops within twenty-four hours, and in seventy-two hours spores cover the surface.

shown in the case of rabies, on the quantity of virus ingested. The rate of multiplication of different micro-organisms is known to vary greatly; it is on this rate probably, and the amount of each virus-poison in the system needed to cause prostration, that the period of incubation largely depends. The great variability of the period for hydrophobia probably depends on the peculiar manner of inoculations by bites in the skin, and the different quantities of virus introduced, for Pasteur finds that in systematic inoculations the period is quite regular, and depends on the intensity and quantity of the virus, and the place of introduction.

The escape of many persons (about 84 per cent.) among those bitten by rabid dogs is due to the virus not gaining access to places in which it can develop (often it is rubbed off by clothes), and probably also largely to the incapacity of many of the microbes deposited in the body to make progress against the living forces opposed to them. Pasteur has been inclined to believe that the prophylactic action of his inoculations was due not to any living germs remaining, but to their chemical products, which inhibited growth of more virulent germs later introduced. Gamaleia thought, agreeably to Metschnikoff's views, that the white blood corpuscles, leucocytes, absorbed and digested the live germs, their power of absorption being trained by progressively stronger inoculation to cope with the actual virus (microbes) of street rabies. It does not appear to be yet settled whether the presence of rabies microbes still alive is necessary in company with their poison products to produce artificial immunity. The probability appears to be that the germ-free poison has an important effect in preventing the growth of rabies microbes deposited in the system, but that the protective power is raised by successive inoculations of rabies microbes gradually increasing from weak cultures to a high degree of virulence. A large quantity of their chemical poison introduced to the circulation secures the body better against attack than a small quantity. By the intensive treatment Pasteur inoculates marrows of 12, 10, and 8 days, three times on the first day, at 11, 4, and 9; marrows of 6, 4, and 2 on the second day; the one-day-old marrow on the third day. This course is repeated on the 4th, 5th, and 6th days, but with fresher marrows, and on the 7th, 8th, 9th, and 10th with marrows successively fresher. This intensive treatment has been more successful than the more gradual treatment with weak virus.

It is very remarkable that large doses of the germ-free virus of rabies do not cause constitutional disturbance, and this fact seems to indicate that the mischief of rabies lies in the evolution of the poison in the brain, spinal cord, etc.

The vaccinating efficacy of rabic inoculation (according to statistics of M. Leblanc and M. Pasteur) is as 160 to 7, or the deaths are 22·85 times less frequent than formerly; the efficacy of Jennerian vaccination (against small-pox) is 21·70 (according to Dr. McCombie); the efficacy of splenic fever attenuated inoculation is 24 (statistics of 200 veterinary surgeons); the efficacy of vaccination against yellow fever appears to be about 10.

Dogs are much more likely to take rabies when bitten than human beings. And we may say of animal diseases generally, that they pass less readily from one kind of animal to another than among animals of the same kind. It may perhaps be supposed that microbes habituated to a particular environment and successful against their particular foes of the body in which they live, are often overcome by new enemies in the new body before they have had time to accustom themselves to the changed conditions.

Vaccination against small-pox, like Pasteur's injections against rabies, is capable of protecting though applied after exposure to infection. "Supposing," wrote Mr. Marson, in Reynolds' Dictionary of Medicine, "an unvaccinated person to inhale the germ of variola (small-pox) on a Monday, if he be vaccinated as late as the following Wednesday, the vaccination will be in time; if it be put off till Thursday the small-pox will appear, but will be modified; Friday is too late, the stage of areola round the vesicle not having been reached before the small-pox has made much progress (unobserved) within the body. The incubation of small-pox is long; about fourteen days."

Three or four principal theories have been held on immunity against infection. The first holds that a zymotic disease exhausts the blood or body of some ingredient essential to the existence of the microbe, so that the same disease cannot usually for a long time recur in the same body: the second holds that a poison is evolved by the microbe which militates against its life, and, remaining in the body, prevents its development if the infection be re-introduced after a long interval: the third regards the microbes as opposed by the leucocytes, certain white cells of the blood, which either succeed or fail in demolishing them and devouring them, and that having once become trained to the war with the microbes of a disease through which a body has passed, they or their descendants are competent to resist future attacks of the same disease; moreover, the strongest and most successful cells and their descendants hold the field: the fourth theory considers certain ingredients and qualities of the fluid part of the blood operative in the destruction of microbes, and complex action to be set up between the invading organisms, the blood, and tissues.

In favour of the first theory (exhaustion), the strongest evidence is the well-established fastidiousness of many kinds of microbes, and their refusal to grow where a small modicum of some particular ingredient is not present, or where the nutritive medium is either acid or alkaline. Some refuse to grow in acid, and some in alkaline media. To the nutrition of the yeast cell mineral salts (alkali phosphates) are necessary; potassium phosphate is very favourable, sodium phosphate ineffectual, magnesium salts are favourable.[1] Many other microbes are still more particular as to conditions of growth and diet. The behaviour of microbes of fermentation, etc., lend some force to the theory, but an objection remains in the probability that exhausted matter would be soon replaced, and susceptibility therefore return. The blood cannot be quite rightly compared to soil which a certain kind of crop renders unfit by exhaustion for the nutriment of another crop of the same plant. At the same time, exhaustion of habitual ingredients in the body, which do not afterwards return to the same degree, may account for many cases of immunity after a first attack of some zymotic disease.

The second theory has a great deal to recommend it, and is supported by the parallel cases of yeast fungi and fermentation, by which a poison is evolved inimical to

[1] Pasteur. Schutzenberger.

the growth of the same fungi again introduced. Here, however, the difficulty arises of supposing that the poison remains so long as seven, ten, or fifteen years in the system.

The third theory, by which the leucocytes or phagocytes of the blood are looked upon as doing battle against the invading microbes, appears to be true in certain conditions, and to account, in combination with some considerations involved in the fourth theory, for many of the phenomena of infection, susceptibility, and natural and artificial immunity.

Suppose a disease germ to enter a capillary vessel. If alone, the irritation may cause a migration of white corpuscles (phagocytes) to the point of attack, and the germ will be devoured. But suppose a microbe had settled on a favourable surface, say in the throat or lungs, and had developed there and multiplied, evolving its appropriate poison. The poison would paralyze or penetrate the thin lining, and enter the blood. Now the action of the phagocytes would be encountered by the paralyzing effect of the microbe poison as well as the microbes themselves. It is very likely that they may be overcome. But the defensive proteids of the fluid blood may save the invaded body, by contending with the poison, perhaps neutralizing it, and enabling the phagocytes to advance and exterminate the microbes. But suppose the phagocytes and defensive proteids to be overcome by the force of the invaders. Then in the course of the disease, as the microbes increase and then diminish and the patient recovers, the blood-cells and defensive constituents of the blood and tissues will be thoroughly enured to their action, and will at any future invasion be strong enough by "acclimatization" or habit, possibly inherited in the case of the cells, to resist the hostile force.

That a habit of resistance to ferment-poisons is quickly acquired by the body as a whole is shown in the case of alcoholic liquors, and a similar habit is acquired against various vegetable poisons. Gradually increasing doses or injections of alcohol, morphia, etc., enable the recipient to withstand without discomfort quantities which if taken at first would have caused symptoms of illness. These effects are probably the result of the sum of similar effects on the blood, tissues, and nerves in their minute constituents.

When an inoculation or vaccination is made, say of vaccine matter, we may imagine that among a multitude of vaccine microbes, only the strongest and best fitted for their new environment resist the action of the blood. These rapidly multiply, and a poison is evolved which is conveyed into the circulation, but the microbes themselves cannot pass from the seat of inoculation and live, so that the disturbance concentrates itself at and about the puncture. The wound and its poisonous contents paralyze the resisting forces there, and the microbe grows till weakened by its own products, and banished by the now acclimatized fluids of the host. The poison of vaccine matter permeating the body with the blood accustoms the system to its action, and the body is thus protected against the action of the small-pox virus poison, which is similar. Small-pox living virus being now introduced, the poison evolved from it is unable to paralyze the action of the defensive proteids and of the white cells, for these have already been trained to overcome the poison of the very similar vaccine virus.

The success of vaccination, in this view, depends on the use of a comparatively uncongenial and attenuated virus, containing living germs of the disease from which it was drawn; on the growth, at the point of lesion, of these germs, and on their formation there of a poison akin to, or the same as, that produced by small-pox germs; on the failure of the germs to pass through the blood, while their poison does so pass and produce more or less disturbance in the body; on the sufficiency of this poison-action upon the system to render it capable of thereafter successfully overcoming small-pox infection. It is probable that small-pox microbes, if introduced to the body, say after the lapse of years, have to encounter fluid constituents of the blood which have retained, in consequence of successful war on the vaccine products, somewhat stronger powers of elimination against the living small-pox microbes and their poison, and that the phagocytes of the blood descended from those which resisted the vaccine are the more capable of destroying the small-pox microbes and of resisting their poisonous products. It should be borne in mind that most unvaccinated persons have in their system cells and fluids which are probably capable of destroying all but the more virulent small-pox microbes, unless the invading number is large. So that what vaccination does is to prepare the body to repel more effectually the organisms of infection.

The efficacy of vaccination increases regularly with the extent or number of "marks" up to five, which affords almost complete protection. This is consistent with the above view, for the fluids and cells of the body are more fully brought into contact with the poison when it has been introduced at several points, and are probably only partially seasoned when the small amount of virus from one or two marks is brought into play.

Small-pox itself is protective against a second attack, presumably for the same reasons as those above given. The cells and fluids are overcome by the virus; but if the patient recovers, they become during the attack better fitted to cope with it, and the germs are thrown off from the skin, etc. On recovery, the system is pervaded by cells and fluids which have proved themselves capable of removing the inimical matter, and this condition is transmitted to the successive constituents of the blood and tissues.

Some such action may occur in several other infectious diseases of men and animals, such as measles, scarlet fever, whooping-cough, yellow fever, typhoid, typhus, anthrax, swine-fever, cattle-plague. In the case of diphtheria, the microbe of which grows on but not in the body, while the poison elaborated pervades the system, we may infer that protection is due to the habituation of the normal cells and proteids to this poison, rendering it difficult for the diphtheria microbe in future to find a lodgment where it can develop freely.

The diseases of animals, where of a character closely resembling human zymotics, appear specially well fitted for cultivation and use as vaccines for mankind. For it is remarkable that several such diseases do not readily infect human beings; they infect slightly and locally, and yet their toxic products can hardly be very different. Horse influenza, pneumonia of the ox, possibly bovine scarlet fever, do not seem to be very readily transmissible to man, and the latter seems to be as slight, comparatively, in the cow, as vaccine in relation to small-pox.

The theory above stated seems to account satisfactorily for many phenomena of epidemics and infection. The disposition to contract zymotic disease in a depressed condition of the system, certain experimental cases of liability of immune animals when their food is lowered, the action of certain poisons, such as jequirity (or abrus), preparing a way for infection, the temporary refractory state produced by injection of blood from an immune to a susceptible animal, the easy infection of the body through wounds where the invading microbe multiplies on matter deprived of vigorous action (as it might on separated serum), the immunity acquired by nurses and others exposed to infection without strong predisposition and with power to throw off microbic invasions, the competence of early vaccination and anti-rabic injections to preclude small-pox and hydrophobia already imported to the system, the importance of fresh air and healthy blood in cases of infectious disease, the preference of zymotic diseases for various periods of life respectively, all receive some light and acquire additional meaning.

If it be possible to discriminate at the present stage of investigation to which many able experimenters have conducted us, we may perhaps observe that it appears likely that the infection of the poisonous products of a disease-organism protects the infected animal for a short or moderate period, and that vaccination with living germs or virus may confer immunity for a long period. Examples of the former are conspicuous in anthrax, in glanders, and perhaps in rabies; of the latter we have examples in the vaccine against small-pox, in rabies, anthrax, and fowl cholera.

In the case of tuberculosis, it seems to be doubtful whether injection of tuberculine would protect at all against the possible contraction of the disease. The slow progress of this disease brings in a new set of conditions, and the phagocytes of the blood appear to absorb without killing the bacilli. In malaria, the organism seems often to find a nidus in some part of the body, where it remains unable to make headway, until a chill or other cause of weakness enables it to emerge and again infect the blood. Other zymotic diseases sometimes recur in these conditions, but exposure to them at the critical moment is required, since their spores do not remain alive within the body. In diphtheria autochthonic recurrence has been observed, the micrococcus apparently lodging in the mouth.

The acid or alkaline condition of the blood is probably a matter of great importance to persons exposed to infection, and it would be of interest to ascertain the most favourable condition for each kind of infective microbe.

At the recent Hygienic Congress in London (1891), much light was thrown by several distinguished investigators on the processes of microbial attack and the defensive powers of the body.

Dr. Roux stated that with the single exception of "vaccination," the only way at present of conferring immunity against any disease is the inoculation of the virus of the disease. Two methods of attenuation had been described by Pasteur: prolonged exposure to air at a suitable temperature, and the passage of the microbes through the bodies of different kinds of animals. In all cases, whatever the method employed, it was found necessary to attenuate slowly and gradually; rapid attenuation rendered a virus altogether inactive, without impressing on it any hereditary weakness. [This observation is of capital importance; it may lead to the scientific culture of an attenuated strain of microbes of various diseases, and their application on emergency to masses of people, schools, etc., exposed to infection, with due preparation of the inoculated subjects.]

With regard to phagocytosis, Dr. Roux stated that the greater the refractoriness of an animal, the more rapidly the microbes were consumed by the leucocytes. In a non-resistant animal the microbes remained free and unconsumed.

In tuberculosis and leprosy the bacilli were to be found in the cells, and the results were of the most serious kind, despite intense phagocytosis. This proved that the phagocytes and all other means of defence were at certain times, and in certain conditions, powerless to save; the microbes adapted themselves to the interior of the cells, and conquered. It is essential that the microbes should be both eaten and digested by the cells. Even in those cases where the struggle goes against the human organism, the cells are still the aggressors.

In lymph taken from the body of a pigeon, numerous bacilli were seen imprisoned in the cells; these grew, and finally escaped. But in the living body phagocytosis is a very general phenomenon, and very efficacious in checking organisms of disease.

Even in immune animals the microbes were found to increase when kept out of the reach of the leucocytes, and their development has been seen to be checked when immigration of the leucocytes took place in large numbers to the place of attack.

Metschnikoff explains the immunity of animals in the case when they have been inoculated with attenuated virus to the habit formed during the struggle with the attenuated microbes. MM. Massart and Bordet proved that the products of microbes exerted a very marked chemical action on the phagocytes. When a virus was introduced into the body, it secreted a substance which attracted the leucocytes; the cells which assembled were paralyzed, and the microbes extended. In chicken cholera, the virus is so poisonous that the cells are repelled from the point of inoculation, but in animals made immune by inoculation of the attenuated virus of a suitable dose of bacterial products, the inoculation of strong virus attracted the cells, and the microbes were taken up by them before they had had time to elaborate sufficient toxic material for their protection. It was therefore at the commencement of the disease that the critical struggle took place. Every cause therefore that prevents the access of leucocytes to the point of inoculation renders infection easy. The theory of Metschnikoff, concluded Dr. Roux, did not exclude the possibility of there being other means of protecting the organism, but laid stress on the great importance of phagocytosis as the chief cause of immunity.

Dr. Buchner stated that, with regard to the anthrax-immunity of white rats, a small quantity of serum was only able to destroy a very small quantity of microbes, but still the serum had the power of totally destroying certain microbes. The experiments of Petruchky, Baumgarten, Pekelhering, and others, seemed to show that the bacilli of anthrax perish in the living fluids of immune animals, even when the bacilli are protected against the attacks of the leucocytes. In every case the living fluids of the body exert a harmful influence on microbes, excretion of protein thereupon takes place from the microbes, and this protein attracts the amoeboid cells to the spot. The germicidal action of the serum is however destroyed by the action of the microbes themselves if they survive it. The germicidal action of the serum is intensified by moderate warmth, 37° C. The serum of animals which took anthrax readily never possessed such a strong bactericidal action as the serum of white rats, which are immune. Facts described by Behring, Kitasato, Ogata, and Emmerich, showed that injection of blood of serum of immune animals cured others affected with the particular disease. Dr. Buchner ascribes immunity to proteid substances, which he calls alexins, formed probably in the cells, but, when formed, independent of the cells.

Mr. E. H. Hankin, of Cambridge, was led by certain theoretical considerations to suspect that a particular ferment like proteid, known as "cell-globulin B," was a substance possessing bactericidal power. He tested its action on anthrax bacilli, and found that it had the power of killing them. He further found that similar substances were present not only in animals naturally immune against anthrax, but also in those that were susceptible. To these substances he had given the name of defensive proteids. The serum of white rats contained a proteid possessing alkaline reaction, and a power of destroying anthrax bacilli. When injected into mice along with fully virulent anthrax spores, it would prevent the development of anthrax. Defensive proteids of susceptible animals did not exert this power. Wild rats fed on plain bread for about six weeks, succumbed to anthrax with which they were inoculated; others fed on flesh did not take it, and their spleens were found to contain an abundance of the proteid. Very young rats, which are susceptible to anthrax, appeared to contain less of this substance than adults, and to resist anthrax when inoculated with the adult's serum.

Mr. Hankin represents his classification of defensive proteids in the following table—

Defensive proteids (Hankin). Alexius (Buchner).	Sozins: Present in normal animal.	Myco-sozins: Alkaline globulins from rat, destroying anthrax bacillus (Hankin).
		Toxo-sozins: Of rabbit, destroying V. metschnikovi poison (Gamaleia).
	Phylaxins: Present in the animal after it has been made artificially immune.	Myco-phylaxins: Of rabbit, destroying pig-typhoid bacillus (Emmerich).
		Toxo-phylaxins: Of rabbit, &c., destroying diphtheria and tetanus poisons (Behring and Kitasato, antitoxin of Tizzoni and Cattani).

A "sozin" is a defensive proteid occurring naturally in a normal animal, and has been found on all animals yet examined. It appears to act on numerous kinds of microbes and their products. A "phylaxin" is only found in an animal made artificially immune against a disease, and appears only to act on one kind of microbe and its products.

Myco-sozins act on the microbe, toxo-sozins on the poisons produced by microbes.

Prof. Emmerich of Munich stated that his previous experiments on swine fever had proved that in immune animals the bacilli of swine fever were destroyed not by the cells of the animal, but by a bactericidal substance present in the blood. The bacilli were destroyed almost immediately after their introduction under an immune animal's skin. Applying these researches to the disease produced in rabbits by the inoculation of the diplococcus pneumoniae of Fraenkel, he showed that non-immune animals died within twenty-four to forty-eight hours. But if such animals had been treated with the blood or serum of animals made artificially immune against the diplococcus, such animals did not die, but recovered after the introduction of extremely virulent diplococci. Moreover, when the diplococcus was inoculated into an animal, it was possible to cure it by injecting shortly afterwards some of the *serum* of an animal rendered artificially immune. Prof. Emmerich considered that his experiments, together with those of Dr. Doenissen, showed the possibility of curing people afflicted with pneumonia by such injections, applied in good time.

Dr. Ehrlich, of Berlin, stated that he had recently made a number of experiments with ricin, which threw much light on the subject of immunity. According to Kobert and Stillmark, ricin is an extremely poisonous body, acting fatally when only 0·03 was injected into an animal's veins. Through the alimentary canal, a dose one hundred times larger could easily be tolerated. A guinea-pig died eleven days after the inoculation of 0·7 c.c. of a 1 in 150,000 solution of ricin. Mice are much more tolerant of the poison. By beginning with harmless doses, and gradually increasing the amount, mice might be made to tolerate doses, previously sufficient to cause death in mice, without any ill effects. Thus, whilst doses of $\frac{1}{200,000}$ gramme was fatal in normal animals, mice fed daily and in increasing quantities with ricin suffered no harm after the injection of $\frac{1}{1000}$ or $\frac{1}{500}$ gramme, or, occasionally, of $\frac{1}{250}$ gramme. Whilst a 0·5 or 1 per cent. solution of ricin applied to the eye of a normal animal produced severe inflammation and panophthalmitis, the application of a 10 per cent. solution of ricin produced no effect on the eye of an animal previously fed with ricin. The subcutaneous tissue, however, could not be rendered immune. He had been able to extract from the blood of animals rendered immune against ricin a body which had the power of counteracting the toxic action of ricin, so that a powerful solution of ricin was rendered harmless by mixture with the blood of immune mice. It was also possible to render animals immune against ricin by injecting the blood of immune animals. He had obtained similar results with abrin.

Dr. Kitasato stated that he and Dr. Behring had found that the blood of a normal rabbit had no effect, but the blood of a rabbit made artificially immune had the power of destroying the toxines secreted by the specific bacillus of tetanus. Moreover, the blood of rabbits made artificially immune against tetanus with trichloride of iodine, rendered mice not only refractory, but also cured the disease when already in progress. The blood appeared to act, not on the bacillus, but on the toxines secreted by it.

Dr. Adam was of opinion that in a large number of infectious diseases the process of phagocytosis is extremely marked. The rat had been the subject of controversy, but the serum of rat's blood certainly possessed bacteria-killing properties to a high degree.

Dr. Klein observed that frogs and rats were insusceptible to anthrax, but that they could be made susceptible by various means, indicating that their normal resistance was due to certain chemical conditions of the blood.

Dr. Metschnikoff stated that bacilli developed freely in the liquid exudation of immune animals, owing to the leucocytes perishing when removed from the body. The vibrions multiplied and filled the leucocytes, which swelled and eventually burst, allowing the microbes to pass freely into the liquid.

Whenever an animal recovers from an infectious disease, the recovery is accompanied, in Dr. Metschnikoff's view, by a process of phagocytosis; when an animal dies, the process is insufficient or absent.

RELATION OF DENSITY OF POPULATION TO THE DEATH-RATE.[1]

Average Death-rate.	Death-rate between	Density (acres to a person).
14·48	14 and 15	2·53
15·60	15 and 16	3·20
16·63	16 and 17	2·48
17·58	17 and 18	3·04
18·53	18 and 19	3·30
19·48	19 and 20	2·94
20·56	20 and 21	1·40
21·54	21 and 22	0·95
22·55	22 and 23	0·49
23·54	23 and 24	0·35
24·41	24 and 25	0·30
25·54	25 and 26	0·23
26·26	26 and 27	0·22
30·23	27 and 34	0·10

The rapid increase of mortality when the average density of population becomes greater than one person to an acre is here very apparent. It is also evident that a rather high death-rate frequently occurs in ill-managed districts which are sparsely populated.

[1] Supplement to the Forty-fifth Annual Report of the Registrar-General. Decennial Report, 1885.

RATE OF MORTALITY IN VARIOUS OCCUPATIONS.[1]

Rate of mortality among		Rate of mortality among (*continued*)	
Clergymen	556	Hairdressers ...	1327
Lawyers	842	Tailors	1051
Doctors	1122	Bookbinders ...	1167
School-masters ...	719	Butchers	1170
Artists, sculptors, architects, etc.	921	Organ-grinders, etc.	1314
Gardeners	599	Slate and quarrymen	1122
Farmers	631	Brewers	1361
Labourers	701	Publicans, spirit-dealers, etc.	1521
Fishermen	552	Hotel servants, potmen, etc.	2205
Bargemen, etc. ...	1305	Maltsters	830
Carters, etc.	1275	Durham and Northumberland miners ...	873
Cabmen, etc. ...	1482	South Wales miners	1081
Hawkers, etc. ...	1879	Derby miners ...	734
Grooms, etc.	887	Ironstone miners ...	834
Commercial travellers	948	Cornish tin, etc. miners	1839
Law clerks	1151		
Shopkeepers	877		
Bakers and millers ...	958		

The rate of phthisis, etc. among gardeners is 232; among farmers, 202; among labourers, 278; among fishermen, 108; among printers, 461. The Cornish tin-miners, owing to a great extent probably to the bad ventilation and high temperature of the mines, have three times as much phthisis as males in general in Cornwall. Among cabmen and hawkers the phthisis rate is very high, and a great excess in their mortality is due to intemperance in drink. The great excess of mortality in the persons employed in the publican's trade is obviously due to intemperate habits. Much allowance has to be made for various disturbing elements and for various conditions pertaining to the

[1] Supplement to the Forty-fifth Report of the Registrar-General, 1885.

above trades. For instance, both miners and schoolmasters are likely to be persons of robust health. It is noteworthy that chimney-sweeps have eight times their due of malignant disease, especially cancer.

NOTES ON MICROBES.[1]

The growth of many microbes is greatly interfered with by the presence of acids.

Microbes differ from animal cells by having a cellulose covering, and by being able to derive their nitrogen from salts of ammonia and nitric acid, while animal cells cannot decompose such stable nitrogenous compounds, but derive their nitrogen from unstable albuminous matter. Microbes cannot decompose the CO^2 of the atmosphere, having no chlorophyll, and resemble the fungi.

Microbes are of varied chemical composition, as shown by their different action on colouring matters, etc.

The Zeiss system magnifies 3 to 4 thousand times. A man so magnified would look as high or higher than Mont Blanc. Their sizes vary from ·0005 to 0·05 mm.; 636,000 million microbes might weigh a gramme.

In some microbes spore formation only takes place when the microbes are growing in contact with oxygen. Low temperature is unfavourable. Spores of bacilli (especially *b. subtilis*) can stand the action of boiling water several minutes. It kills the grown bacilli.

Anaerobic microbes still require oxygen, which they derive from the medium in which they live.

[1] See *Micro-organisms*, by Griffiths.

Fission is the usual means of multiplication. Cohn says after 24 hours a single bacterium has increased to 16,777,220. After two days there will be 281,500 millions. The first of these numbers would fill about $\frac{1}{40}$ of a cubic mm.

Buchner believes that *b. subtilis* can be transformed into *b. anthracis*. Chauveau found that *b. anthracis* loses its virulence after exposure to compressed oxygen, but remains vaccinal; recovers its virulence when grown in suitable media. Klein does not believe in the *transformation* of bacteria.

Bouchard[1] attributes the following maladies to micro-organisms—

Measles	Osteomyelitis	Diphtheritic angina
Erysipelas of the face	Amygdalitis	Pulmonary phthisis
Erysipelatous angioleucite	Pseudo-rheumatism	Purulent bronchitis
Puerperal fever	Typhlitis (ulcerous)	Rabies
Herpetic fever	Dysentery	

Virchow, Klebs, Eberth, and others, hold that certain micrococci are the specific elements which account for the peculiar malignancy of ulcerative endocarditis.

Boils have been found capable of inoculation by rubbing a pure culture of staphylococcus aureus on the skin. The microbes enter the shafts of the hair to the follicles and thence spread.[2] This observation leads to the suspicion that some other pathogenic microbes may enter the body in this way, and that boils may sometimes be caused by the common use of hairdressers' gowns, brushes, etc. during hair-cutting.

1 *Medical Congress*, 1881, vol. i.

2 *Lancet*, March 8, 1890.

BACTERIO-THERAPEUTICS.[1]

About 1877, Pasteur published a statement containing the suggestion that it might be possible to build up a system of bacterio-therapeutics. The range of his view is shown by this generalization in theory from one experience, or at all events very few ascertained facts. He had observed that the microbe of fowl-cholera could not be induced to grow in fluids in which it had been previously cultivated, and was rendered sterile, and he had applied this observation to living animals which had passed through one attack of the disease; he then found by actual experiment that the specific microbe was no longer able to set up the disease. Further than this, he was able to foresee, what has been since to some extent verified, that the products of the life of one kind of disease organism within the body might be poisonous to the growth of some other disease.

In 1887, this view was confirmed by an experiment of Watson Cheyne, who injected anthrax bacilli into rabbits, and immediately after injected the streptococcus of erysipelas, by the action of which the anthrax was prevented from causing fatal results. Bouchard found the same effect with bacillus pyocyaneus. Messrs. Woodhead and Wood did not find that pyocyaneus was able to kill anthrax outside the body.

Most organisms, during the period of development from the spore, pass through a very delicate stage, in which they are very susceptible to the action of antiseptic substances; and they will only germinate fully

[1] *Bacterio-Therapeutics.* Woodhead and Wood. *Laboratory Reports of the Royal College of Physicians,* vol. iii.

under special conditions, such as suitable temperature and a free supply of oxygen.

Probably, in outside cultivations, it was an alkaline by-product, to which anthrax is extremely sensitive, that prohibited the growth of anthrax.

The addition of another microbe to an infection in an animal, may increase its action and make it fatal. The products of a number of organisms were found by Roger greatly to aid disease-germs of another kind.

The soluble poison of the jequirity bean produces a condition of blood, etc., in which several *non-pathogenic* organisms become seriously harmful. Saprophytic (putrefactive) organisms do produce very small quantities of the same poison as the parasitic form. By using the saprophytes as *vaccines*, animals were protected against anthrax. The blue pus products appear to antagonize the specific action of the anthrax toxine, and the anthrax thus falls a victim to the germicidal action of blood and tissue, just as does an ordinary saprophyte. The process of physiological antagonism is usually regarded as consisting in the antidote depressing those actions (of the toxic products) which have been excited by the poison, but it may be through a tolerance of the poison by the cells, which retain, perhaps latent, this acquired tolerance. "We may regard antidotal action as due to the power of stimulating into temporary activity that condition which occurs in a more permanent state where the cell has acquired immunity."

Dr. Binz[1] has observed that quinine has three very important properties, which may explain its action on malarial infection—(*a*) it is a very powerful protoplasm

[1] *Medical Congress*, vol. i.

poison; (*b*) it remains a long time in the body without change; (*c*) it is not poisonous to the human organism.

DISTRIBUTION OF MICROBES IN THE AIR, SOIL, AND WATER.

M. Miquel found that the air contains a large number of microbes (mostly harmless), and that the number is much greater in towns than in the country.[1] Micrococci are the most numerous class, about two-thirds of the whole. At Montsouris Observatory the number of microbes per cubic metre was 75; at Mont-parnasse Cemetery, 150; in the Rue de Rivoli, 750. In rooms the number was eight times, and in hospitals twelve times the number in the open air. The number of microbes in the open air was 70 in spring, 92 in summer, 121 in autumn, 53 in winter. Prolonged heat with dryness diminished the number. In hot countries, after a period of great heat, the number of microbes and of cases of infectious disease diminish. The places where microbes are most numerous are centres of infectious disease. The curves of mortality from infectious diseases correspond to a great extent with those for the number of microbes, and follow them at a short interval of time. M. Miquel computes that air traversing Paris at four metres a minute, carries in one day from the town forty million million of bacteria. Smaller and unseen germs must be more numerous.

In one gramme of dust of his laboratory at Montsouris, he found 750,000 germs, in one gramme of a room in Paris 1,300,000, and in that of another room 2,100,000.

[1] See Comptes Rendus; also *Les Virus*, by Arloing.

In the air of hospitals microbes of suppuration have been found, staphylococcus aureus and streptococcus pyogenes.

In dried earth (1 gramme), M. Miquel has found from 800,000 to 1,000,000 microbes. In rain-water, per litre, 64,000. In the Seine above Paris, 4,800,000; below Paris, 12,800,000; in sewer water, 80,000,000.

The quantity of organic matter in a soil affects enormously the number of organisms. The number is very great on and near the surface in the neighbourhood of dwellings. It rapidly decreases with depth, and at one metre there are few. Bacillus, chiefly in the form of spores, constitutes 90 out of 100 of the microbes of the soil.[1]

Ice from ponds fed by the Spree at Berlin contained 21,000 germs in the cubic centimetre.

The following table shows the power of growth of bacteria in different waters, the figures indicating the number of days to which this faculty extended—

	Distilled Water.	Ourcq Water.	Vanne Water.
Anthrax ...	—	28	65
Cholera ...	14	30	39
Typhoid ...	69	81	43
Glanders ...	57	more than 50	more than 28
Streptococcus pyogenes	10	14	15
Blue pus ...	13	20	73

The virulence of various disease-germs in water (ponds and streams) has been studied by Kraus, Bolton, Karlynsky, Galtier, Cadéac, and others. For suppuration microbe the period of virulence was 20 days; for anthrax spores, 1 year; for the 'mycelium' of anthrax,

[1] *Les Virus.* Arloing. 1891.

4 months; typhoid, 2 months; cholera, 4 days; glanders, 9 to 20 days; tuberculosis, 10 to 12 days.

Dr. Dundas Thomson[1] found that in the wards of a cholera hospital sporules of fungi and germs of vibriones were obtained by filtration of the air. Fungi and their sporules extended to the top of the rooms. Similar microbes were found in the air outside hospitals; in the air of a sewer, sporules, fungi, and vibriones. In the sewer the air was alkaline.

In Angus Smith's experiments with water shaken in the air of different places, he found that to produce an effect visible to the eye, much more air must be used in the country than in the town; that the air of a cow-house will give an appearance to the water which will not be caused by good air unless from 50 to 100 times the amount is used. The air at the front of houses in streets is decidedly better by this test than the air behind the houses, at least where open middens are used. These effects are seen simply by shaking pure water in a bottle in the air to be washed. Air taken from a cow-house contains a mass of débris, with hairs or fine fibres. In water (150 drops) shaken with 2495 litres of the air of Manchester, the number of germs, etc. was about 37½ millions.

Mr. Smith says—"After the known and the probable action of all these bodies, we are driven to seek for the conveyance of infection in the solid bodies of the atmosphere, not forgetting that some may, like albumen, be dissolved in water or be carried in little globules like pus."

Moisture collected from the air by artificial con-

[1] Report published by General Medical Council, 1852. See *Air and Rain*, by Angus Smith.

densation above marshes has been found by Italian observers to contain multitudes of seeds of algæ and of microscopic infusoria. Dr. Pietro Balestra says the condensed dew exhibits a surprising quantity of spores and sporangia.

There is a great variation in the power of resistance possessed by the individual microbic organisms in an ordinary cultivation, and conditions which exert a rapidly destructive influence on the majority of the microbes *leave the more hardy individuals of the same culture unaffected.*[1] With Koch's comma spirilla and b. pyocyaneus in drinking-water, only a small proportion survived and multiplied.

Dr. Frankland found[2] that in crude river-water the number of microbes decreased after storing two to four days at ordinary temperature, but increased enormously in an incubator at 35°. Slight multiplication takes place in filtered river-water, even in cold weather. At a temperature of 20°, multiplication is very great, and at 35° enormous. Filtered water at 20° C. allows much more rapid multiplication at 20° C. than unfiltered. In deep well-water at 20° multiplication took place from 7 to 495,000 in three days. When b. pyocyaneus is put into distilled or pure water, the numbers at first decline, then considerably increase. When put into sewage, there is large and rapid multiplication. Koch's comma bacillus grew rapidly in various waters, very extensively in sewage, from broth cultivations. From the gelatine it did not grow, being apparently too weak. The behaviour of the comma bacillus depends largely on the source whence obtained, but in sewage large

[1] *Proc. Royal Society*, 1889. Dr. Percy Frankland.
[2] *Proc. Royal Society*, vol. xl., 1886.

multiplication takes place, in contradistinction to the result in well and filtered waters.

The bacillus subtilis is always present in the air.

In catching atmospheric microbes Miquel found that sea-salt, although it has marked antiseptic properties, raises the nutritive power of the bouillon in regard to microbes, when not exceeding five to seven grammes per 1000 cc. of bouillon. Sodium or magnesium sulphate and sodium phosphate also favour multiplication.

The spores of anthrax are known to retain their vitality for months in drinking-water or on moist soils.

It has been proved that a fly can convey the virus of anthrax from a diseased to a sound animal.

It has been experimentally proved, and accidentally shown, that the bacillus of anthrax and of tubercle is in the air of a room where experiments upon these bacilli are being carried on, and cross-infections have occurred indicating both a subtle and easy distribution of these bacilli in the air and a capability of infecting after passing through the air.[1]

Dr. Klein has proved that swine fever (pneumo-enteritis) is due to a bacillus transmissible from pig to pig *through the air.*

Pasteur exposed ten tubes to the air of Paris for a short time; all were rendered turbid (with bacteria). At the summit of Montanvert, close to the Mer de Glace, one out of ten was affected. Freudenreich lately counted 3·44 microbes in the cubic metre at 2300 metres, twelve torulae, and one or two bacteria in two cubic metres at 2900 metres; none at 4000 metres.[2]

Of twenty flasks opened in Arbori, eight developed

[1] See *Micro-organisms and Disease*, by Dr. Klein.

[2] *Les Virus.* Arloing. 1891.

living organisms; of twenty opened on the Jura, five became affected; of twenty opened on the Montanvert, only one was affected.[1]

Tyndall showed by a number of very beautiful and classic experiments, which can only be alluded to here, that micro-organisms do not affect cultivating media placed in air which has been for some time undisturbed, and that the dust and micro-organisms in the air subside within a few days in a closed space, the path of a beam of light no longer being made visible, as in ordinary conditions, by a multitude of floating particles. And above all, he showed that the development of microbes invariably depends on the conveyance by air or by outside media of organic particles, and not on independent development within sterilized or cultivating material.

Dr. Frankland made experiments[2] on the number of microbes contained in the open air on the roof of the Science Schools at South Kensington. The average number of colonies obtained from 10 litres of air was, in January 4, March 26, May 31, June 54, July 63, August 105, September 43, October 35, November 13, December 20.

He also made experiments with the view of ascertaining the relative abundance of micro-organisms at different altitudes in towns. At the top of Primrose Hill the number was 9, at the bottom 24. At the top of Norwich Cathedral 7, on the tower 9, at the bottom 18. In the Golden Gallery of St. Paul's Cathedral 11, in the Stone Gallery 34, in the Churchyard 70. On Reigate Hill 2 in February, 13 in May. On a heath

[1] *Journal of the Society of Arts*, March 25, 1887. Percy Frankland.
[2] *Ibid.*

near Norwich in April, 7 and 5; in a garden at Reigate in May, 25; in a garden at Norwich in April, 31. In Kensington Gardens, 13 in April; in Hyde Park, 43 in May, 18 in June; in Exhibition Road, 94 on June 7, 554 on June 8, 18 on June 10. In the air of buildings the number was much higher when people were moving about; thus, the number in the Natural History Museum was 50 on May 21 in the morning, 70 in the evening, 280 on Whit Monday. In Burlington House (Royal Society), 326 on June 9, 130 on June 10. In the Consumptive Hospital at Brompton, 43, 130, and 42, at different times on May 21; 19 and 34 on June 1. In Dr. Frankland's own laboratory, where care was taken to prevent dust, the number was 13 in 10 litres.

The number of microbes falling on one square foot in one minute was in the Chemical Laboratory 15, in Kensington Museum 54, in the Natural History Museum 196, in the same on Whit Monday 1662, in Burlington House 222, in Brompton Hospital, 54.

In a third-class railway-carriage, one window open, four persons present, between Norwich and London, 395. The carriage filled up at Cambridge, and the next experiment, made near the closed window, the other window being four inches open, gave the enormous number of 3120 per square foot per minute. In a barn where flail-threshing was going on, 8000. [It may be assumed that the former specimens, in the railway-carriage, were much more likely to be mixed with pathogenic organisms and with harmful matter, than those raised in the barn.]

The experiments with Hesse's tubes, and with apparatus of Dr. Frankland's construction, showed the mould fungi to be much lighter than the other organisms, and they consequently reach more easily to high altitudes and to great distances from their source. The hay bacillus, subtilis, is very common in the air, also the bacillus chlorinus, and the micrococcus candidans.

Since it may be fairly assumed that the presence of a large number of microbes of a harmless character often implies the presence of others of pathogenic power, the examination of air, with reference to the number of contained microbes, may be usefully employed as a rough test of its wholesomeness in various localities and buildings. "The scanty microbial population of country, of mountain, and more especially of sea air, which these investigations reveal, point to the security from zymotic disease which these surroundings are well known to confer. . . . We learn moreover the great importance of removing all dust and refuse matter generally in a moist condition, and with the least possible delay, for the micro-organisms present in a moist substance can only be distributed to air in two ways: firstly, through its desiccation and conversion into dust; and secondly, through the formation of spray, especially through the generation of gas in the liquid medium, *e.g.* in the putrefaction of sewage."[1]

DISTRIBUTION OF MICROBES IN AIR OF HOSPITALS, SCHOOLS, ETC.

Mr. Greenleaf Tucker made, during the winter of 1888-89, an investigation[2] into the distribution of microbes in the air of the Boston City Hospital,

[1] But see Appendix on this point.

[2] See *Public Health*, July 1890.

which consists of thirteen buildings, of which nine are exclusively devoted to the sick.

It was found that ten litres of the air outside the hospital contained on an average ten colonies of bacteria, seven of moulds, in November; fourteen of bacteria, six of moulds, in December; thirteen of bacteria, and three of moulds, in January. The number of bacteria was greater on clear than on rainy days. Some of Mr. Tucker's results may be here very concisely stated. Bacteria were more abundant in the medical than in the surgical pavilion. Bacteria are most abundant in the mornings. (This is probably owing to disturbance by sweeping, etc.) Bacteria were most abundant where there was most movement. In a scarlet fever ward one sample gave 4·2 per ten litres; in a diphtheria ward 7·1. In the time of most disturbance in the morning the bacteria were 4·2, the moulds 10·3 before sweeping, and 70·8 and 17·8 after sweeping. After midnight, when the wards are quiet, the number of bacteria per ten litres is one, or less than one. Bed-making, next to sweeping, seems to increase largely the number of microbes in the air. The number of bacteria found in the reception-room was sixty-four, in the hall forty-eight, in the dining-room eighteen, in the private office twelve. A large number, average 20·1, was found in the domestics' rooms, which are badly ventilated. The air of the hospital was on the whole remarkably free from bacteria, showing the result of constant care for cleanliness. Carnelley found in clean one-roomed houses 180 bacteria per ten litres, in dirty houses 410, in very dirty 930; in naturally ventilated schools 1250, in mechanically ventilated schools 300; in the Royal Infirmary, Dundee, 10 to 20. It is clear that a very great deal can be done by ventilation and cleanliness to reduce the number of microbes in private and public buildings.

SAPROPHYTIC PROTECTION.

The researches of Hueppe and Wood[1] on the relationship of putrefactive or saprophytic, and parasitic or pathogenic bacteria, were undertaken in the belief that the division between these two classes is conventional, not real, and they endeavoured to prove the close connection between some of these classes by experimental inoculation.

In garden earth there is a bacillus which cannot be distinguished from anthrax save by the crucial test of inoculation into animals; mice inoculated with this saprophyte are quite unaffected; mice inoculated with anthrax rapidly die. It was found that by inoculating with the saprophyte before inoculating with anthrax, a number of mice were protected against fatal results, and those which died lived much longer than control mice not so prepared. With guinea-pigs similar results were obtained. The authors conclude that "as the parasites of such diseases as cholera and yellow fever have without doubt developed from the local saprophytic flora of the regions in which they occur, and as the cholera microbe has not even yet advanced from the simple facultative parasitic stage, we have no reason to doubt that the original less virulent organisms still exist in these endemic regions, and that the influence which such places exert on their inhabitants depends

[1] See *Public Health,* January 1890.

on the presence of such harmless organisms, which, without causing the disease, can yet confer a certain protection." Thus in 'endemic regions' the inhabitants enjoy a certain freedom from the disease.

HOSPITALS.

Mr. Burdett, in a paper[1] on the unhealthiness of public institutions, contended that institutions containing large numbers of people under one roof were not of necessity unhealthy, and that it is possible greatly to improve the health of hospitals, asylums, schools, convents, refuges and homes. Since the prisons have come under the control of Government, they have gradually been made, probably, the healthiest residences in the United Kingdom. Dr. Gover, in the second Report of the Prison Commissioners, showed that in all the prisons of England and Wales, during one whole year, only one case of small-pox, and not a single case of scarlet or typhus or gaol-fever occurred. Only fourteen cases of typhoid occurred, five of which were in one prison in an infected district. In the majority of prisons there was not a single case of typhoid. In the fourteen cases reported, the origin of the disease was invariably traced to sanitary defects, which were proved to have been in existence before the prisons came under Government control. Why, then, do the authorities of other institutions look upon the presence of a certain number of cases of zymotic disease as unavoidable? From his experience of convents, refuges, homes, etc., Mr. Burdett is convinced that for the most

[1] *Transactions of the Sanitary Institute.* 1879.

part residence within their walls must be highly dangerous to health. "The probabilities are decidedly against there being one in ten of such institutions that would stand an impartial investigation into its drainage arrangements without producing as startling revelations as those made at Manchester and Frome. The condition of public and private schools is often terribly deficient."

What, then, is to be done? First, let every committee, council, or board of governors, or responsible person, ask for a plan of the drainage arrangements of the hospital, asylum, or school under their charge. Let there be no loss of time in testing its accuracy, and, under any circumstances, let them procure a report from a competent expert of the exact sanitary condition of all the buildings in their charge. If the authorities neglect so plain a duty, it will not be unreasonable for a jury to bring in a verdict of manslaughter should any deaths be produced in future by sewer-gas, from causes similar to those exposed at the County Asylum at Frome.

Private houses and public institutions are at present, in comparison with prisons, highly dangerous abodes for any persons susceptible to zymotic infection. It would be a great gain if a Special Sanitary Inspector could be appointed, whose whole time should be devoted to the inspection of public institutions.

HOUSE CONSTRUCTION.

Houses in large towns are permeated by an atmosphere laden with impurities, which are constantly being deposited on any surface which will retain them. It is important to avoid having places where impurities are likely to lodge.[1] The interspace between floors and ceilings is a cavern for the undisturbed collection of dirt. In a London school the space between the joists, when a board was taken up, has been found nearly filled up with an accumulation of filthy matter. Even in ordinary houses the amount of dirt which stores itself between the joists is astonishing. Floors should be constructed of solid concrete and iron, with wood blocks bedded solid on them. Other flooring surfaces may be employed—tiles, removable matting, or carpets. Roofs may be made flat, to avoid the useless space between roof and ceiling. Cisterns should be open to daily inspection. Plaster, finished hard for paint, is preferable to wall-papers; at any rate, papers should not be of rough or flock surface. Generally, hard, easily-cleaned surfaces are to be preferred.

Leaking sewers, drains, gas-pipes, ashpits, etc. with pervious bottoms, filth and garbage lying about, all befoul the earth. The earth being foul, not only does the air resting on it reek with poisonous emanations, but all water-supply derived from wells becomes impure, and the air drawn from it through the basement area is noxious. The inhabitants of a farm-house may be as easily poisoned by these conditions as those of a city.[2]

Dr. Russell has shown very clearly the great effect of density of population in increasing the prevalence of disease. He has found in Glasgow, on comparing houses of different sizes, that—

[1] International Congress of Hygiene, 1891. *Insanitary Superstitions in House-building.* H. H. Statham.

[2] *The House in Relation to Health,* by Dr. J. Russell, of Glasgow.

1. The unit room in large houses has a much higher cubic value than the unit room in small houses.

2. The smaller the house, as measured by rooms, the greater the number of inmates per room, and *vice versâ.*

3. The smaller the house, the less the cubic space per inmate, and *vice versâ.*

Pollokshields has houses averaging a little over eleven rooms, each inhabited by ·627 persons, and a death-rate of 10.

Next comes Hillhead, with houses of six or seven rooms, with ·83 persons per room, and a death-rate of 10·5.

Then Crosshill, with five or six rooms, ·929 persons; death-rate, 12.

Then East Pollokshields, with five rooms and a fraction, 1·071 persons; death-rate nearly 14.

Then in similar progression up to Kinning Park, with scarcely two rooms between two and three persons, and death-rate 23·3.

House-space becomes a predominant factor when we approach an average house of five apartments, and a mean occupancy of more than one per apartment. Experience proves that the occupants of small houses cannot be left to their freedom of action in the matter of space. Physical and moral chaos will gradually invade the original order, if the eye, either of the landlord or of the inspector, is not kept upon the householders to prevent overcrowding. It has been truly said—"In crowded districts, where the lower orders are neglected, if tubs were ticketed to be let they would soon be tenanted." If, on the other hand, we keep up the standard of house accommodation, we may lead the flagitious and improvident to mend their ways. Nothing will help so much to thrift and self-restraint as the fact that there are no miserable houses to be had.

The death-rate over a series of years in the buildings of the Metropolitan Association for Improving the Dwellings of the Industrious Classes, has varied from 14 to 17 per 1000; in the buildings of the Improved Industrial Dwellings Company, it has in 16 years averaged 16·2; and in Newcastle the death-rate for 1882 was only 12 per 1000 in the new dwellings, compared to 21·6 for the rest of Newcastle.[1]

No condition of health in towns, however, approaches that of the prisons. During the five years ending June 1882, nearly 2000 prisoners passed through Newcastle prison; during the whole of that time there was no death from zymotic disease in the prison, although there were epidemics of scarlatina, typhus, and small-pox in the borough. During three of the five years there were no deaths at all of prisoners admitted without previous disease, whilst in 1879 the deaths in this class were ·027, and in 1887 ·025 per 1000.

In the Report of the Directors of Convict Prisons for 1890-91, it is stated that no death occurred during the year from any defect in sanitary arrangements. The death-rate was only 7·4 per 1000, in a daily average of 4870 prisoners. Occasionally prisoners who are hopelessly ill are removed from prison, but these cases would not largely affect the given rate.

The mortality of children under ten in the Industrial Dwellings was 24·04; in the Metropolis generally it was 47·66 per 1000.

The health of some Asylums and Orphan Institutions for children is very far above that of children in the

[1] *Trans. Sanit. Inst.*, 1882-3. Sir Douglas Galton.

same class of the general population. In the district half-time schools near London, where the sanitation is the best advanced, the death-rate among the children, many of whom are of the lowest condition, did not exceed 3 per 1000, or one-third of that of children in the common or Board schools. Regular head-to-foot ablutions with tepid water, and complete skin cleanliness and clothes cleanliness, has been found an important factor in the prevention of disease among children.

It is well worth considering whether better provision for baths, and for clean clothes for children attending school, would not conduce to economy by the prevention of disease and epidemic outbreaks, and by the increased vigour and attention which would result from increased cleanliness and a purer atmosphere in school.

In some portions of the United States the great importance of regular sanitary inspection is recognized, rather than dependence on private complaint, and the registration and certification of houses before they are let or sold is insisted on.[1] By the New York Health Law only 78 per cent. of a building plot is allowed to be built upon, and the height of the block is regulated by the width of the street. A tenant cannot get water supplied until the plumbing is certified.

Impervious foundations, hollow walls, inner walls and ceilings of Parian cement, floors of oak, teak, or pitched pine, or other close, hard wood, with close joints, oiled and beeswaxed, and rubbed to a polish, are recommended for hospitals.[2] Even deal floors may be used by

[1] International Congress of Hygiene, 1891. *Homes of the Working Classes.* Dr. E. Gould, of Washington.

[2] *Sanitary Record*, Dec. 15, 1885. "Hospitals and Hospitalism," by Dr. John Eaton.

being rendered impervious by filling with solid paraffin, or by painting with soluble glass. Polishing once a month with wax and turpentine is necessary.

It is important to note that diseases are more injurious in foul air than in low temperature. Almost open-air treatment may, with judgment, be very successful with typhus, enteric fever, small-pox, etc.

At a height about equal to that of a high house (say 70 feet), a much more equable and drier climate prevails than at lower levels, much less cold on the coldest and especially on foggy nights than near the ground.[1] The mean daily range at a height of 128 feet nearly approaches that of the English sea-coast. It is very important for health that (1) the living-rooms should be well raised above the ground; (2) that the house should be well ventilated underneath: the liability to disease, especially rheumatism, is much less among those who live near the top of high houses than in those who live on the ground floor.

Low confined situations in valleys are much colder at night, and have a greater annual range of temperature than the ridges and sides of hills.

SCHOOLS.

Dr. Shelly, Medical Officer to Haileybury, considers schools especially susceptible to epidemic influences, as they consist of a closely-aggregated population of young people to a great extent unshielded by a previous attack.[2] Day-schools are especially open to infection from without;

[1] *Transactions of the Sanitary Institute*, 1882. "Improvement of Climate with Slight Elevation," by R. Russell.

[2] International Congress of Hygiene, 1891.

but in all schools infection is brought from without to a very great extent after the holidays, etc. When the number of unprotected reaches a certain proportion of the total scholars, an epidemic outbreak may be expected with certainty. In the case of measles the number attacked in a full outbreak will be about three-sevenths of the unprotected, *i. e.* about one-seventh of the whole school. The influence of this "explosive ratio" explains the tendency of epidemics to recur at approximately regular intervals of time.

In order to prevent epidemics in schools, an efficient health-certificate system is required, and the enforcement of efficient quarantine and disinfection after exposure. When infection has been introduced, early notification of illness, early and effective isolation and disinfection of patients, is important. Greater immunity is secured by the subdivision of the school into separate senior and junior establishments.

The experiments of Mr. Carnelley and others show the very urgent importance of good and thorough ventilation in schools.[1] This seems to be much better attained by mechanical or power ventilators than by trusting to natural outlets, which fail just at the most critical time, in still and foggy weather. Linoleum, or impervious wooden floors, without open cracks, and smooth washable walls, are exceedingly desirable to prevent the lodging and multiplication of bacteria.

HEALTH OF PORTS.

The general death-rate of Cardiff in the ten years ending with 1854 was 32·7 per 1000; in the ten years

[1] *Sanitary Record, Society of Arts Journal,* etc.

ending with 1889, it was 19·7 per 1000, although the population was more than six times as large.[1] During the same period the death-rate from infectious diseases was reduced from 98 to 31 per 1000. The typhoid-rate declined from 19 per 10,000 in 1845-54 to 3 per 10,000 in 1874-83. Cholera killed 51 in 10,000 in 1849, 18 in 10,000 in 1866, and since that date has not succeeded in gaining a footing, although cholera has been imported nine times into the port or district. These cases were dealt with in accordance with the Cholera Regulations of the Local Government Board. There are however serious shortcomings in the coast defences against disease. Responsibility is too much divided between the Customs, the Board of Trade, and the Local Authorities. The sanitary functions devolving upon these would be better performed by one undivided authority. In the reports on the sanitary survey of port and riparian districts, by the inspecting officers of the Local Government Board, it is recorded that "a notable number of authorities, some of them acting for districts with a considerable amount of shipping trade, were found to have done nothing in the way of inspection of vessels, and that the riparian authorities generally have taken no means to ensure the wholesome condition of vessels." It appears that local authorities do not recognize their responsibility in this very important matter, and that the detection and treatment of infectious illness on ships is left to the Customs authorities. Similarly, the ventilation allowed to a sailor, and the cubic space of his sleeping-place, are often far below what is permitted on land. Power to compel the cleaning and emptying of

[1] Congress of Hygiene, 1891. Dr. Walford on the Improved Sanitation and Health of Seaport Towns.

polluted water-tanks on board ship is also required, and has at present only been conferred specially on some port sanitary authorities. The Archdeacon of Gibraltar has lately called attention to the large number of cases of cholera, typhoid, etc., caused by bad water and absence of filters on board ships. Disease on board ships of course leads frequently to disease in ports, and *vice versâ.*

QUARANTINE, ETC.

Medical inspection, to detect actual cases of illness; maritime sanitation to destroy the micro-organisms of disease in vessels, clothing, etc., with, in some cases, the detention under quarantine of observation of "suspects" for a term varying with the period of incubation of the particular disease, constitute the practice covered by the expression "maritime quarantine."[1]

In Canada, quarantine is entirely under the National Government; in the United States it is under the various States, and in some cases, the sea-board cities. There are national quarantine stations, and it is expected that in future vessels requiring treatment will be sent to the nearest of these national stations.

There is a general acceptance of steam, the mercuric chloride drench, and fumigation with sulphur dioxide, as the recognized means of disinfection.

The main requirements for a quarantine station are held to be as follows:—1. A boarding station, so placed as to command the channel leading to the port. 2. A boarding steamer, fitted with

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[1] International Congress of Hygiene, 1891. "Modern Quarantine in Canada and the United States," by Dr. Montizambert, Medical Superintendent, Canadian Quarantine Service.

hospital cabins for landing the sick, and with appliances for disinfecting in the offing ships' hospitals with the mercuric chloride drench, and with steam, when such disinfection is found to be all that the vessel requires. 3. A reserve steamer to replace the usual boarding steamer on emergency, and—where the station is isolated—to act as supply and mail steamer, for the forwarding of convalescents, etc. 4. An anchorage for vessels under quarantine of observation. It should be placed conveniently for the main establishment, and safely remote from the track of commerce. 5. A deep-water pier. The depth of water at low tide at its end should be at least equal to the draught of the largest vessels coming to the port, with a frontage sufficient for such vessels to moor to it if required. Upon this pier there should be constructed: (*a*) A warehouse; (*b*) elevated tanks for disinfecting solutions; (*c*) a disinfecting house containing steam disinfecting cylinders; (*d*) sulphur furnaces, engine, exhaust fans, etc., for fumigation. 6. A lazaretto or hospital for the treatment of infectious diseases. 7. Separate accommodation for non-infectious cases from infected vessels in quarantine. 8. Detention houses for the detention under observation, in groups, of "suspects" or persons who have been exposed to infection. 9. Quarters for officers and staff. 10. Telegraphic communication with the rest of the world. Telephonic communication between the different parts of the station. 11. A bacteriological laboratory. 12. A cremation furnace for the disposal of the bodies of those who have died of infectious diseases.

The disinfection appliances may be described somewhat more at length.

Mercuric Chloride Drench. Upon the pier a framework is erected some 35 or 40 feet high. On top of this is a circular wrought-iron tank, capable of holding about 8000 gallons. The top of the tank is closed by a secure cover to prevent access of light to the solution. On the top of this cover is placed centrally a wooden cask holding about 60 gallons. In this the mercuric salt is dissolved, and then let down into the tank through a wooden faucet; 65 to 70 pounds of the mercuric chloride are used for one charge, the strength of the solution used being from 1 in 700 to 1 in 1000. In the tank near the lower edge are three heavy faucets of galvanized iron, to each of which is screwed a lead of one-inch four-ply rubber hose. The ends of these lie on the pier, and are lengthened by additional sections to reach any part of the largest vessel. To the far extremity of each hose a nozzle, or a rose for spraying, is attached, provided with a stop-cock. During disinfection all three leads may be used simultaneously, fore, aft, and amidship. On a single vessel from 1500 to 3000 gallons may be used in drenching and spraying all attainable surfaces of the vessel excepting cargo, but including ballast, hold, saloons, forecastle, decks, etc. The process requires from half an hour to two hours, according to circumstances. The bilge-water also is replaced by this solution.

Steam Disinfecting Cylinders. These chambers, two or three at one station, consist of jacketed, cylindrical shells, made of strong boiler iron, each shell being 40 or 50 feet long and 7 or 8 feet in diameter, inside measurement, and furnished with doors at each end. All clothing, bedding, hangings, etc., are taken from vessels undergoing maritime sanitation, placed in the cylinders, and allowed to remain for 15 to 20 minutes subjected to a temperature of 230° Fahr. dry and moist heat. A crane is provided for swinging the movable doors or heads into and out of place. The cylinders are covered with hair-felting and canvas to prevent radiation. The clothing, etc., is hung on trucks with clothes racks; these are admitted at one end and taken out at the other. The steam is admitted into the manifolds from a stationary boiler close at hand. The cylinders are provided with safety-valves variously weighted and set, according as steam under pressure or streaming steam may be preferred. Dry heat is first introduced, raising the temperature to 180° to 190° Fahr.; steam is then turned on, bringing the thermometer up to 230°, at which it is held for some twenty minutes or half an hour.

Sulphur Dioxide Fumigation. Various patterns of furnaces for sulphur fumigation are in use. They are all alike in the principle of driving the sulphur fumes by powerful fans with great power and velocity into the closed holds or apartments of vessels, so as to force the fumes into every cranny and crack. The confined air of the hold having first been expelled, is replaced by an atmosphere surcharged with sulphur dioxide. The fan is run by a special engine. The furnaces are connected to the vessel by a pipe of galvanized iron and asbestos cloth of one foot in diameter. An average of three or four pounds per 1000 cubic feet is employed, and the fumes are generally kept for twenty-four hours in the vessel's hold.

One very good form of this furnace is that introduced by Assistant-Surgeon Kinyoun, United States Marine Hospital Service. It is on the principle of a reverberatory furnace, consisting of a series of shelves arranged one above the other, each shelf holding a pan of sulphur. A forced draught is kept up by means of a fan-blower connected at the bottom. The draught of air charged from the burning sulphur of each shelf is made to reach and pass over the shelf above by means of apertures made by shortening the shelves alternately at their front and back ends. With an experimental furnace repeated experiments gave Dr. Kinyoun from 14 to 16 per cent. of sulphur dioxide, temperature 21° Centigrade, while burning sulphur in a closed space gave only 6 per cent. at 21° C.; *i. e.* it would not support the combustion of sulphur above that percentage. A more recently modified furnace at Charleston, South Carolina, has given gas testing 18 per cent. sulphur dioxide.

Quarantinable Diseases. The Canadian regulations have always, since their first promulgation in 1832, included "Asiatic cholera, fever, small-pox, scarlatina, measles, or any other infectious or dangerous disease." In some parts of the United States the list is limited to yellow fever, typhus, cholera, and small-pox. At ports, however, where there is immigration, the list is more extensive; thus at Boston it includes also diphtheria, scarlet fever, typhoid fever, and measles; and at New York, with all the above, relapsing fever is also mentioned, "and any disease of a contagious, infectious, or pestilential character, which shall be considered by the health officer dangerous to the public health." Within the last two years leprosy has been added to the list, both in Canada and the United States; and in the latter country, since the 1st of April last, consumption is classed amongst the dangerous and contagious diseases barring admission, immigrants suffering from it being now ordered to be returned to the ports from whence they came.

CONVEYANCE OF ANIMAL DISEASES TO MAN.

A patient was shown at the Dermatological Society, Berlin, who had been engaged in attending to cows affected with foot and mouth disease.[1] While engaged in anointing the udders of a cow an abscess broke and the pus from it ran over his finger. About the fifth day an efflorescence appeared on the finger, and later

[1] *Public Health*, August 1891.

fever came on with inflammation of the lymphatics of the right forearm. The characteristic efflorescence now appeared on the arm, and the symptoms lasted about a fortnight.

Small local diseases of animals, such as abscesses on the cow's udder, are often transmitted to men.

Anthrax (wool-sorter's disease), cow-pox, diphtheria, glanders or farcy, tuberculosis, scarlet fever, rabies, are all capable of being transplanted from the animal to the human body. Animal diseases usually assume a somewhat different type when planted in man, and similarly, human diseases affect animals often somewhat differently. It is worthy of remark that atmospheric conveyance is very inapt, as a rule, to infect man with the diseases of animals. They must be strongly implanted in the new environment of the human system in order to grow.

Origin of Plagues and Infectious Diseases. Some diseases of plants seem to be capable of transfer to, and possibly, occasionally, growth in, the animal and human body. Of these the ergot of corn, the disease or mould of maize, which produces pellagra, are examples. But we probably have here to do with the ingested poisonous products of the microbe rather than its growth and action in the body.

As to the microbes which feed on dead organic matter in the soil, named saprophytes, many of these are certainly capable of thriving in the blood and substance of the body. Malaria clearly arises from the transplantation to the body of organisms which usually feed on vegetable débris in moist soil at a high temperature. It is easy to imagine how other diseases, for instance, cholera, dysentery, tuberculosis, plague, diphtheria, influenza, and scarlet fever, originally became pathogenic to man by gradual transference say from malarial soil or vegetable débris or animal remains to pools drying under a hot sun, or to blood and offal in the village cesspit, or to excremental filth in crowded huts, all these perhaps at a temperature not remote from that of the living blood, and from some of these natural culture-fluids to the bodies and blood of living persons in the most miserable condition of starvation, anæmic, "half-dead," and feeding very likely on offal, their poor remains of blood loaded with excrementitious pabulum similar to that on which the saprophytic microbes were indigenous. Habituated to the living body, at first attacking only the least robust, but by a process of survival of the most virulent germs gradually gaining power to invade more healthy bodies, in the course of years representing many thousands of bacterial generations, the modified saprophytic germ would become known as an infectious disease, and in its vigorous multiplication and invasion attain a stable form and habit, capable of planting itself in the living man only less easily than its original stock flourished in devitalized organic substance.

If this view be correct, it is important not only to provide against the contiguity of filth and bad air to mankind, but to insure as far as possible against any set of people in any part of the globe becoming subject to floods, famine, and distress. Wholesome food might be provided by the insurance of all nations to relieve the sufferings of people overtaken by exceptional distress, and a like provision might be made for animals. It is said that recently in Russia many thousand horses have been killed owing to want of fodder.

MILK.

Dr. Ostertag considers that it is the undeniable duty of the State to see that only pure milk enters the market. The consumer is not in a position to guard himself against the manifold dangers which attend the consumption of milk.[1]

Colostral milk; blue, red, and yellow milk; slimy, thready, salt, bitter, bad-smelling, muddy milk; milk of animals fed on poisonous fodder, or suffering from tuberculosis, malignant pustule, cow-pox, aphthae, or generally ill, with ulceration or ichor, must be regarded as not good for health.

It is necessary (1) that all dairy farms be licensed; (2) that animals kept for milk be examined from time to time by a competent man; (3) that only good fodder be given, and that immediate notice be given by the farmer of any disease in a cow; (4) that the business of milking, etc. be performed with the most punctilious cleanliness; (5) that the milk be cooled and stored in special rooms; (6) that it be transported in suitable vessels; (7) that during the prevalence of aphthae only boiled milk be brought into the market, and that at the outbreak of any infectious illness in a dairy farm, the sale of milk be forbidden; (8) that in the case of "milk for children," especially strict regulations be carried out as to feeding the cows, cleanliness, cooling, and transport.

Milk, as derived from the living animal, must be to a great extent a reflection of the animal's state of

[1] International Congress of Hygiene, 1891. "Regulation of the Milk Supply."

health.[1] Milk has a remarkable power of absorbing gases, organic and inorganic, and is besides a fluid which possesses all the properties necessary to constitute it a suitable cultivating medium for low forms of life, fungoid or bacterial. Hand-feeding amongst all classes has enormously increased, and seems likely to increase still more. It is to children we must look, as the great consumers of cows' milk, for evidence of disease caused by its contaminations. After examining the evidence of transmission of a number of diseases from cows or milk to children, especially scarlet fever, diphtheria, typhoid fever, and tuberculosis, Dr. Parkes contends that it will be necessary in future to quarantine cows suffering from even slight and undefined illness; to prevent cows coming into regular milking for trade purposes until a safe time after parturition; to provide for cleanliness in milking operations; and to exercise throughout the country such a supervision that the existence of disease among dairy-hands and their families, or among the cows themselves, may no longer pass unrecognized. The Milkshops Order of 1885 contains the necessary powers; enlightened public opinion has to insist on their proper enforcement. Dr. Sykes, Dr. Hill, and others strongly insisted on the importance of invariably boiling milk before consuming it.

Dr. Sykes, M. O. H. for St. Pancras, has dealt very fully[2] with the conditions which ought to be fulfilled in the farm and dairy in order to insure a safe supply of milk to the consumer. The lighting and ventilation of cowsheds, the cleansing, drainage, water-supply, the

[1] *Transactions of the Sanitary Institute,* 1886-7. "Milk and Disease," by Dr. Louis Parkes.

[2] *Transactions Sanitary Institute,* 1887-8.

cleansing of the milk-store or shop, and of the vessels, the provisions against infection and contamination, are carefully reviewed, and among the valuable suggestions brought forward, the construction of cow-sheds on hygienic principles, the isolation of sick cows, and of sick attendants, quarantine for newly-arrived animals, proper water-supply in lieu of foul ditches and ponds, and better regulation of milk-shops, may be noted.

Dr. Hope of Liverpool stated that he had over and over and over again found out the existence of scarlet fever in cow-sheds and also in milk-shops where children were lying up-stairs, and the mother in attendance on the sick-room, which she would leave to serve customers. Dr. Tatham found in some cases that milk was sold in a shop separated by a partition only from a room where scarlet fever existed.

Dr. Bryce has pointed out[1] the inadequacy of the powers of local authorities in respect to dairies, and that however unfit the premises for the purposes of a dairy, registration cannot be refused. In 90 per cent. of the cases examined by him for a dairy supply association, there was no attempt at registration. The reporting of cases of infectious illness at dairy-farms is frequently neglected; the cow-sheds are often very much below the proper standard, and when extra accommodation is required, the cows are lodged in any hovel or outhouse. He suggests that local authorities should have power to refuse to register unsuitable persons or premises; that all dairymen should be required to notify cases of infectious disease; and that local authorities should have power to amend or control the condition of the cows' out-door life. During seven or eight months of the year the

[1] *Sanitary Journal.* See *Sanitary Record,* May 15, 1889.

animals mostly drink from polluted ponds or other improper sources, as water from wells sunk near a cesspool. No newly-purchased animal should be admitted into a cow-shed until it has been subjected to one month's quarantine in a shed by itself. If udder-disease breaks out, arrangements for isolation should be made.

CERTAIN CONDITIONS FAVOURABLE TO SPREADING DISEASE.

At Ashton-in-Makerfield, the medical officer reported that in 1890 in all cases of infectious disease a bad sanitary condition of the premises, either as regards drainage, ash-pits, or surroundings, invariably existed.[1] School attendance was also a means of spreading the infection. The report of Dr. Taylor, medical officer for Scarborough, states that he invariably found that diphtheria arose either in insanitary conditions of houses and premises, or has been directly traceable to the intercommunication of school-children.

Many other medical officers have laid stress on the importance of these two factors in the production of disease.

PUTREFACTION IN DRAINS, MANURE-HEAPS, ETC.

Experiments have shown that an offensive smell is often indicative of a less dangerous property of putrefying matter than the slight fœtid odour of an old drain, ash-pit, or manure-heap, and that organic matter after putrefaction has been going on a long time is often in a condition highly dangerous to health.[2] Mr. Chadwick

[1] *Sanitary Record*, May 15, 1891.

[2] *Transactions of the Sanitary Institute*, 1882-3.

insisted on the great importance of removing all noxious matter rapidly from the vicinity of dwellings, expressing the principle by the maxim, "Circulation *versus* stagnation."

PIG-KEEPING.

Dr. Nasmyth, the medical officer for Clackmannan county, suggests[1] the following rules for the avoidance of nuisance and disease from pig-keeping—

1. The pigsty to be removed as far as is possible from a dwelling-house, and in no case to abut on or communicate with a dwelling-house.

2. When any number of pigs are kept the house should be built of brick or stone, and to the satisfaction of the county inspector, ventilated from the roof.

3. The flooring to be of concrete.

4. The pig to be washed and supplied with clean litter frequently.

5. Manure should not be allowed to accumulate.

6. On no account will pigs be allowed to be kept in a byre where a cow is kept.

DISINFECTING.

It is very important that operations of disinfection should proceed on a uniform and scientific plan. "We are probably many of us familiar," wrote Dr. Ransome, in 1877, "with the appearance of bowls filled with a blood-red fluid placed about a room, or with the dishes of chloride of lime or pastiles of sulphur sending forth faint odours of gas into the chamber; and yet used in this fashion these disinfectants would probably give as

[1] *Sanitary Record*, Aug. 15, 1891.

little security against infection as the famous saffron-bag whose virtues are so extolled by Mr. Caxton." It is not even now generally recognized that antiseptic is not synonymous with disinfectant power. In country and suburban towns we are accustomed to see a pink dust thrown from time to time on street gratings, and many are the compounds vaunted as disinfectants or germicides which are really only efficacious for particular microbes in particular conditions. Earth, Air, Fire, and Water are, as Dr. Ransome insists, Nature's own means of destroying noxious matter, but they must be given fair play. Among chemical disinfectants, sulphurous acid, used strong and for many hours, and chlorine, are efficacious if carefully used twice over. For walls and floors, if not very dirty, Guttmann and Merke, and Bordoni-Uffreduzzi, recommend a solution of 3 in 1000 bichloride of mercury, acidulated with 5 in 1000 hydrochloric acid. (*Annales de l'Institut Pasteur*, Feb. 1892.)

Thorough exposure to a temperature of 230° F., and especially to superheated steam, is always the best disinfection, where practicable.

RELATION OF WEATHER AND SEASON TO HEALTH.

The investigations of Mr. Alexander Buchan and Dr. Arthur Mitchell on the relation of weather to health are well known and of great value as affording means of determining some of the causes or conditions which increase or diminish the prevalence of each disease for which the curves have been plotted, the relations of diseases to each other, and the manner in which they invade the system. The subject is a wide one, and can only be touched upon here.

It is plain that a certain kind of season and weather may give rise to an excess or maximum of a disease by direct influence on the growth of the microbe, or by helping to spread the spores or microbes, or by increasing the supply of some food on which the microbes feed, or by producing effects on human conduct which favour the spread of the disease. Thus the increase of whooping-cough and small-pox in the winter may be due to the closer aggregation of human beings allowing it to spread more quickly; the increase of scarlet fever in the autumn may be due to the re-assembling of schools and to the return to town and congregation from distant places of resort, in some of which the disease has been prevailing, or it may be due to an actual increased growth of the microbe in warm weather, say in farmyard manure and in milk. Another factor in the seasonal curve of scarlet fever may be acidity of blood, caused by consumption of sour fruit, apples, etc. The enormously high development of diarrhœa in hot weather seems to show an actual increase in the number of microbes developed on polluted soil and in adjacent articles of food and drink when raised above a certain temperature. Pneumonia, laryngitis, bronchitis, and asthma show their great dependence on cold weather for excessive development; that is, they apparently attack surfaces inflamed or injured by cold; enteritis, debility, and thrush are most fatal in hot weather, when the bowels are more affected. The curves for summer diarrhœa for different towns are very remarkable, showing very large differences between the amounts of this disease, depending on locality and not altogether on temperature. Evidently, the study of disease in relation to weather requires careful discrimination, and the disposition to connect, biologically, diseases which exhibit similar curves must be cautiously exercised. Still the field open for investigation is a very promising one, and the curves which have been already made out for London are full of interest. The part played by temperature would receive further elucidation by a comparison of the temperature curve for London or some other locality with the curve of prevalence of any particular disease, and by a comparison of these with the temperature curve and disease curve along a line of longitude or with gradually increasing or decreasing temperature.

Humidity in relation to diseases might be similarly treated. In this way the factors of climate would be separated from those of soil, of habits and ways of living, food, drink, etc. So far as we may judge from present data, it seems that temperature, especially temperature of soil, of water, and of milk exposed to the air, is a very important element in relation to the development and multiplication of disease-germs, and in relation to the manner in which the human body will dispose of them. We may remark, parenthetically, the suggestive fact that influenza in cold weather and cold countries largely attacks the respiratory organs, and in warm weather and warm countries largely attacks the bowels. Also that influenza appears in many different forms in different persons, often affecting greatly those parts of the body in which some weakness exists. Humidity is beyond question an extremely important factor in the development and distribution of disease-germs. A dry climate and soil, where there is little vegetable matter decaying on the surface, and little animal filth in the neighbourhood of dwellings, is usually very free from disease, if ordinary hygienic conditions be observed. In the desert, wounds are said to heal with wonderful rapidity and with freedom from the dangers of damp or crowded localities. There is evidence that in damp places an immense number and variety of microbes infest the air. But in populous countries, rainy weather, and especially a wet summer, is rather favourable to human health, for the germs of disease are washed down and prevented from rising into the air and being breathed in as dust.

We must, however, be on our guard against attributing too much effect to atmospherical and climatic conditions. Every year we have in our fields, woods, and marshes a growth of a variety of fungi, and perhaps of algae, and we know that most kinds spring up more abundantly in wet, and some in dry seasons, and that each has its appropriate time of appearance. But if we want to get rid of any of these kinds of fungi, we do not attribute them to climate, but rather to soil, nutrient material, and certain conditions which we may reduce. Summer and damp come every year, and with high temperature and moisture a certain number, more or less, of fungi.

Epidemic diseases depend on conditions which admit of attack and removal, and weather and climate deserve attention chiefly for the light they throw on the disease-nature. We are accustomed to put responsibility on the weather, which really lies on ourselves. In a community which attends to the first principles of cleanliness and health, there are very few diseases of the zymotic class which need cause any trouble, whatever the climate or season. The chief exception to this rule is malaria, for which the great remedy is extensive drainage and improved water-supply. Cleanliness in all things, with good nutrition, does away with plague and pestilence in any latitude. In our own country the sources of fever belong to local policy and private habits, rather than to soil or climate.

Ships at sea which have started without germs of infection on board, remain free from the diseases which have been under review. Islands are similarly immune, unless they retain some infection once before introduced. Small remote islands seem even to be free from catarrh, and probably the same immunity prevails in lighthouses and on high mountains, except when the germs are occasionally introduced or borne on the clothes of the inhabitants. Persons living on islands and mountains in houses free from disease-germs, with clean surroundings, and themselves uninfected, might live any number of years without suffering from zymotic disease.[1] Thus it appears certain that disease-germs are not, unless with extreme rarity, borne to the healthy in a potent condition in the general atmosphere.

This conclusion, which has been put beyond question by modern scientific inquiry, is made more easily intelligible by the results[2] of examination of air from different places, which show that air at a distance from towns, especially on hills and in the open country, is very much less occupied by dust and by microbes than the air in the towns, and that on the ocean the number diminishes almost to the vanishing point.

[1] The health of prisons which are clean and isolated is remarkably good, and the freedom from zymotic disease is almost complete. The death-rate in convict prisons for 1890-91 was only 7·4 per 1000. The only deaths from zymotic diseases were nine from tuberculosis, and four from pneumonia. The total daily average number of prisoners was 4870.

[2] See especially Aitken, Miquel, Percy Frankland.

M. Miquel, of Paris, found in the open streets about 3000 germs in a cubic metre; in an old house in Paris 45,000 in winter, and 26,000 in spring; in the wards of the La Pitié Hospital 90,000 in winter, and 54,000 in spring. There were fewer in the warm weather, as the windows were then more opened. On mountain-tops the number was only one, and over the ocean 0·6 in the cubic metre.

DISEASE OF THE ZYMOTIC CLASS SPREADS BY HUMAN AGENCY.

Infection by communication is the grand cause of epidemics and of epizootics. If we look at influenza, which may be usefully taken as a type of zymotic disease, we find that it spreads where there are human communications and aggregations, but not where these are absent. Zymotic evil does not as a rule come through the open atmosphere, or from the unpolluted ground.[1] The general atmosphere is the great purifying agent. The soil may be hard and frozen, and covered with snow, so that microbes do not escape from it, yet influenza, and most other zymotics, will march across countries unarrested by these conditions. But human habits, on the contrary, have a paramount effect in promoting or stopping the growth of the malady. Cold weather, snowstorms, continuous rains, may cause a great increase of indoor life and crowding, and consequently of microbic disease. Ill-ventilated churches and schools serve as foci of infection. Still, close weather, by preventing the salutary change of air which

[1] Malaria is the most conspicuous exception to this rule.

wind helps to keep going on in our houses, may likewise contribute to the same result. When cold and a foggy calm are simultaneous, the conditions are favourable for the spread of diseases, which pass best in vitiated and rebreathed air. Schools, and promiscuous gatherings in bad air, are well fitted for the perpetual diffusion of zymotic disease, for the presence of one infectious person in a crowded room will cause a number of the susceptible to succumb, as was recently conspicuously demonstrated in the influenza.

Some zymotic diseases seem to depend largely for their growth on the undisturbed collection of filth on the surface of the earth. Probably cholera, diarrhœa, diphtheria, and other germs grow in this way to an enormous extent on matter outside the body. Large towns are most healthy in wet summers, especially when the weather is showery and stormy, and when the streets, backyards, drains, etc. are washed of their ordinary filthy dust and deposits.

ABSENCE OF ZYMOTIC DISEASE IN ISLANDS WITHOUT FREQUENT COMMUNICATIONS.

According to Assistant-Surgeon Going, who when writing had been in the West Falkland Islands about two years, there was in these islands a total absence of zymotic disease; "this I attribute not to the increased healthiness of the place by improved sanitation, . . . but to the fact that none has been imported from Stanley or elsewhere."[1]

For the ten years ending in 1860, the only one of

[1] *Public Health,* June 1891.

the 627 registration districts of England which had an entire escape from certain zymotic disorders, viz. measles, scarlet fever, and small-pox, was the district of the Scilly Isles.[1] It was also one of the seven districts in which no death from diphtheria occurred.

Epidemics and plagues take longer to reach islands little visited than places on the mainland. In Iceland influenza epidemics usually do not break out till the spring or summer, that is, soon after communications are fully established with the mainland. Many other islands are exempt from influenza while it is raging on the continents, and the disease, if it occurs at all, breaks out after the arrival of ships from infected places, though sometimes there may be no actual cases known on board. The dates of occurrence of influenza on islands and ships in the epidemic of 1890 are very instructive as given in the Report by Dr. Parsons of the Local Government Board.

Well-governed islands of small size are practically free from the great majority of infectious diseases and epidemics; these only occur as a result of human importation. An interesting example of the importation of malaria to Mauritius was given at the Hygienic Congress of 1891. The malaria, which had not previously afflicted the inhabitants, became a very fatal and common pest after the immigration of some persons suffering from the fever, and it has apparently planted itself in several situations. This observation is of interest as showing that live malaria spores had never succeeded in crossing over the sea between Africa and the island by atmospheric transport.

[1] Sir John Simon's Reports. See also *Floating Matter in the Air. Dust and Disease.* Professor Tyndall

ORGANIZATION.

The organization of the London Fire Brigade is an example of efficient and well-maintained machinery for the prevention of loss of life and property by fire. The force of men and appliances are now as follows— 822 officers and men; 55 fire-engine stations; 52 street stations; 179 fire-escape stations; 4 river stations; 8 steam-tugs; 13 barges, 9 carrying engines; 9 steam fire-engines on barges; 47 land steam fire engines; 95 manual engines; 105 hose-carts; 224 escapes; 133 horses. The proportion per cent. of serious fires was, in 1866, 25; in 1890, only 6 or 7 per cent.

If a national organization against fever, or against zymotic diseases in general, existed on anything like a proportional scale, the lives which would be annually saved in this country may be estimated by tens of thousands, and the cases of illness by hundreds of thousands. Central control is the chief present need.

The Metropolitan Asylums Board has done admirable work in the contest with disease in London. One hundred and six thousand nine hundred and four sick persons have been removed by the land and river ambulances; these removals have been carried out in all weathers, and to a great extent during the night, without detriment to the patients, and without serious mishap to any person. Prior to the opening of the Board's hospitals, in 1870, the annual mortality per 1000 from scarlet, typhus, and typhoid fever, was 1·88, 0·15, and 0·30 respectively; since the opening the rates have fallen (1890) to 0·19, 0·00, and 0·14.

UNITY OF ADMINISTRATION.

The importance of simultaneous and united action is put by Dr. Russell as follows—"In the practice we have not much to learn, but in the policy a great deal, in the concentration of the function, in the guidance of the practice, so that there may be uniform and united action over the entire area of what ought to be in reality, as in name, the community. All the weapons of the sanitary armament ought to be stored in one armoury, and wielded under one command."[1]

ZYMOTIC DISEASE AND SANITATION IN INDIA.

In India surface drainage, and the improvement of village conservancy, are required almost everywhere.[1] Most towns of large size now have their waterworks, and thousands of additional tanks and wells have been excavated. Sanitary measures at fairs now make cholera outbreaks rare; formerly they were very frequent. There has been a great reduction of small-pox throughout the country, owing probably to vaccination. Cholera has become much less common in the improved towns, and the same may be said of dysentery. Fevers, however, are still exceedingly common, and the chief cause of death. In those irrigated parts which are not fully supervised, fever is more common than formerly. According to Dr. Pringle, in one part of the country

[1] *The Policy and Practice of Glasgow in the Management of Epidemic Diseases.* Dr. J. B. Russell.

[2] International Congress of Hygiene. "Sanitary Progress in India." Sir W. Moore.

the making of a high-level canal "has transformed the district into a pest-house."

Surgeon-Major Handley, in a full paper on the condition of Rajputana, stated the ordinary condition of a typical capital town to be somewhat as follows—The poorer classes defile the outskirts of the town, the vacant spaces, old buildings, and nearest highways; the rich inhabitants have places so much out of repair that the whole house and neighbourhood reeks with foul odours from contaminated soil and masonry. Drainage is very imperfect, and the sewage, deposited on low ground, becomes a hotbed of infection, whilst the wells and tanks in the vicinity are of course contaminated. At the close of the rainy season houses and wells in low-lying situations have been frequently proved to have been the starting-points of serious epidemics. Drainage from broken pipes saturates the walls of very many houses. Bullocks and horses are stalled below rooms, and here the sick also are lodged. Milch kine pick up a living on the streets, and act as scavengers. At night they live in filthy byres. The litter from stables and cess-yards, if not eaten by the animals themselves, is used over and over again until it rots. The solid excreta of cattle are turned into fuel; the liquid saturates the earth so deeply that the wells are befouled, and the soil charged with saline matter. Wells are usually situated in low places, while the general level of the surrounding soil has been raised by solid impurities and sweepings so much as to be, in some cases, many feet above the doorways of the houses. Villages are very unhealthy after the wet season. But they are swept by the life-giving winds which blow violently during many months of the year in Northern

India. The ways of defiling water and food are innumerable. On the margin of the village tank, the dead are burned, the dyer carries on his filthy trade, the buffaloes wallow in the mud, the sacred kine drink, the Brahmans wash their clothes and persons, and the women fill their water-pots. The washing in water inconceivably filthy, merely as a symbolical religious act, the deposit of filth near wells and tanks, the religious obstacles to cleanliness, all contribute to mortal disease. The women are employed for many hours every day in preparing with their hands animal manure as fuel, so that the poor cannot have clean food. Dogs, cows, swine, peafowl, kites, and vultures do a large amount of scavenging, and it is said that in Bikanir, a city of perhaps 50,000 inhabitants, there are 10,000 pariah dogs. The lactation of children by their mothers long after they can run about, and the universal boiling of milk, perhaps explain the number of children who survive infancy. Nearly all the milk comes from foul-feeding cattle. The author next described the considerable advances recently achieved in the sanitary administration of Rajputana.

The tank, says Mr. Justice Cunningham,[1] is often mere sewage. Every shower washes surface-filth into it; every dust-storm carries some more; a perpetual series of bathers adds daily to its impurity; clothes and cooking utensils add their modicum of dirt; as the dry season lasts it grows dirtier and dirtier. . . . A long, straggling bazaar in Calcutta exhibits the provisions of the inhabitants on the vendors' stalls, close upon the drain. The heat, the rainfall, the wretched huts on foul soil, the foul food, combine to produce an excessive

[1] *Journal of the Society of Arts*, Feb. 3, 1888.

mortality. Cholera and fever are lavishly sown and abundantly reaped. In 1885, 385,928 persons died of cholera, 3,396,239 of fevers, and 293,638 of bowel complaints.

Sir Douglas Galton observed that "till the Government of India establish General Boards of Health it is vain to say that they have at heart any real desire for sanitary improvement." The English Government owe to the world the prevention of India from continuing to be the breeding-ground and hot-bed for the propagation of cholera.

Cholera, in Mr. Latham's opinion, is almost entirely due to the defilement of wells, tanks, and rivers.[1] The consuming thirst of the cholera patient leads directly to the speedy contamination of unprotected water-supplies. This has been shown in the enormous reduction of cholera in Calcutta by the introduction of the public water-supply into that place, and even the recent extension of the supply to some of the suburbs of Calcutta has produced an immediate and enormous diminution in the deaths from cholera. River-water supply, after a sufficient purification by length of flow and by perfect filtration, is among the most wholesome in the country.

In the years 1877-88 the death-rate of the city of Calcutta was 28·7 per 1000; in the suburbs it was 47·25. When Calcutta was first supplied with water in 1876, and before its sewerage works were carried out, the average death-rate for five years previously had been 38·2 per 1000.

Well-water seems to furnish nine-tenths of the population of India with their supply. The well is

[1] International Congress of Hygiene. "Sanitation in India," by Baldwin Latham, Mem. Inst. C.E.

often little better than a hole in the ground, the sides of which are often the home of pigeons or other birds, while at the bottom is a deep layer of leaf-mould through which the water rises.[1] The roots of trees often lead surface-drainage into the well. There are no parapets, and in the rains these wells are practically converted into cess-pits. Wells on the line of march are frequently the cause of an outbreak of typhoid in a cantonment, and wells at railway-stations are so polluted that the spread of epidemics over India with a rapidity before unknown is easily explained. "It is a most hazardous proceeding to use river-water in India for a drinking-water supply, and nothing would induce me to use it without boiling it first." Tank and pond-water is even worse than rivers. For the cleaning of wells a Bull's dredger was found to be incomparably the best, cheapest, and most efficient method. This should be regularly used for every group of wells.

The Calcutta Health Officer in 1875[2] remarks on the saturation of the soil with soiled filth and liquid sewage, the habits of the people being worse than those of savages.

The Sanitary Commissioner of Madras reported as follows on the town of Cumbum in 1875—"The chief predisposing causes of the abnormal sickness and mortality of the town were, in my opinion, the crowding of every available spot within its limits with corpses, and the pollution of its water-supply. The exciting cause is malaria arising from a swamp which, owing to partial silting up of an important irrigation channel, has

[1] International Congress of Hygiene. London, 1891. *The Water Supply of India*, by Surgeon-Major Pringle.

[2] *Report of Sanitary Measures in India*, 1875-76, pp. 32, 33.

replaced for about two miles the running stream which originally drained efficiently the irrigated lands. More tombs than living persons are visible in the town. The borders of wells and water-channels seem chosen especially for sepulture."

In a Report by Dr. Crombie, of Rangoon, the causes which prevent the low-lying lands of Burma, which are inundated during the rains, from being hot-beds of malaria, are instructively set forth. According to Theobald, he says, the Gangetic delta is an area of subsidence with a deposit of recent alluvium (from 60 to 80 feet thick at Calcutta), while the Irrawaddy delta is undergoing elevation, and only about 200 square miles of it are covered with recent alluvium. The effect of the yearly flooding of the country in depositing new alluvium is nearly *nil*, because the flooding is really produced by the hill-streams.

The old alluvium, which is exposed to the sun on the cessation of the rains, is poor in organic matter, and not suited to the production of malaria.

According to the Sanitary Commissioner of the Central Province of India, severe outbreaks of fever usually follow the rapid drying of saturated soil by a hot sun.

The Army Sanitary Commission, in their Report on the North-West Provinces in 1875, directed special attention to the following practical results of the Reports of the Sanitary Commissioner—

1. The tracing of the Doab fevers to want of drainage in connection with irrigation works.

2. The efficiency of vaccination when properly carried out.

3. The practicability of introducing perfectly safe

arrangements for the disposal of sewage when deposited on the ground by covering it up at once, as illustrated at Bijnor.

The influence of a supply of good water was well shown in the improvement of health at Fort William, near Calcutta, after the introduction of a fresh supply from better sources.[1] The death-rate of troops fell from 68·96 to 10·6.

The diffusion of disease-germs from microbe-bearing and polluted soil by the wind in clouds of dust, such as are common in India and other Eastern countries, is a probable means of extension of some epidemics.

The prevalence of respiratory diseases is shown to be widespread and very fatal to large numbers in all parts of India. In the Report on the Bengal Native Army in 1875, it appears that these diseases exceptionally occupied the first place as a cause of mortality.[2]

There is reason to believe that improper and insufficient food, overcrowding, carelessness with regard to chills, and uncleanly habits and surroundings, contribute largely to the prevalence of these diseases. Unhealthy blood, previous attacks of malaria, and insufficient clothing, would predispose the lungs and weaken resistance.

EXAMPLES OF LIFE-SAVING IN TOWN AND COUNTRY.

In 1874, the deaths registered in England were in every year fully 125,000 more numerous than they would have been if then existing knowledge of the chief causes of disease, as affecting large masses of population,

1 *Transactions of the Epidemiological Society*, 1882, 1883; Surgeon-General de Renzy.

2 *Report on Sanitary Measures in India*, 1875, 1876, p. 70.

had been reasonably well applied.[1] The number of persons needlessly suffering from infectious or zymotic diseases might fairly be put at ten times that number, say 1,250,000 a year.[2] The average annual sickness (incapacity) for the ages of 21—70 has been calculated at $2\frac{1}{2}$ working weeks, and the work-value or wealth lost to the country by this sickness is about £13,306,687 per annum.[3] For every day of sickness saved in the whole average of sickness in heads of families, the wealth of the country is increased by more than £1,000,000. In Edinburgh, the cases of typhoid and scarlet fever alone cost the town about £42,000 per annum. The amount thus lost in London must be something like half a milion a year. Typhoid in 1884 caused in England the loss of 230,000 weeks. Sir James Paget computed[4] the loss caused by disease to the working-classes of England at £11,500,000. The number of weeks of illness of all persons between 15 and 66 is about 20,000,000.

In the decade 1871-81, the death-rate in England and Wales fell from 22·5 to 21·27, implying the survival of 299,385 persons, and saving from illness 3,000,000 persons. The zymotic rate fell from 4·14 to 3·36.

Many towns have by sanitary works largely reduced their death-rate, but country districts and many small towns have on the whole advanced very little in salubrity, and abound in cultivating-grounds for death in many shapes.

1 *Report to the Privy Council*, 1874; Sir John Simon.

2 The proportional amount of disease has diminished and the population has increased since 1874, so that these figures probably are not far wrong if applied to the present state of the country.

3 Edinburgh Health Lectures, 4th Series.

4 See *Journal of the Society of Arts*, Feb. 3, 1888.

The following tables show the vital achievements of various English towns and districts from the year 1841, but they cannot be regarded as accurate, and the death-rate of many towns for the later years of the decade 1881-90 appears too low, owing to population having been over-estimated. The case of Liverpool is conspicuous in this respect, the population having been put too high by 100,000, making a difference of three or four in the estimated death-rate for 1889.

Towns and Districts.	Death-rates.				
	1841-50.	1851-60.	1861-70.	1871-80.	1889.
Portsea (inc. Ptsmouth.)	25	23	21	19·9	18·1
Winchester ...	21	20	19	17·6	
Reading	24	22	22	19·3	
Oxford	23	22	22	18·7	
Northampton ...	24	25	25	22·7	
Peterborough ...	21	20	20	18·7	
Bedford	23	20	20	18·5	
Cambridge ...	23	20	22	19·7	
West Ham ...	18	20	20	17·8	
Ipswich	23	22	22	22·2	
Gt. Yarmouth ...	23	25	24	22·9	
Isle of Wight ...	17	17	17	17	
Plymouth ...	25	24	23	22·6	25·2
Exeter	25	24	25	25	
Scilly Isles ...	19	18	20	22·1	
Bath	24	22	22	21·5	
Bristol	29	28	29	25·5	17·5
Gloucester ...	24	22	22	20·9	
Stafford	22	22	23	23	
Wolverhampton ...	27	28	24	22·8	20·6
Birmingham ...	26	27	27	25·8	18·7
Warwick	20	21	21	19·8	
Nottingham ...	26	27	24	22·9	17·1
Chester	23	22	23	21	
Liverpool	36	33	39	33·6	21·6
Chorlton (incl. pt. Manr.)	25	24	25	23·6	
Wigan	28	27	29	25·8	
Manchester ...	33	31	33	32·9	27·2
Preston	25	27	28	28·1	30
Barrow	18	20	21	18·3	
Huddersfield ...	22	22	24	22·4	18·6
Bradford	25	26	25	23·9	19·2

Towns and Districts.	Death-rates.				
	1841-50.	1851-60.	1861-70.	1871-80.	1889.
Leeds	30	28	30	26	22
Halifax	22	24	24	22·6	21·5
Sheffield	27	28	29	27·4	20·9
York	24	24	24	21·6	
Hull	31	25	26	24·5	20·2
Scarborough ...	21	21	22	19·5	
Durham	23	23	21	25·5	
Sunderland ...	24	25	24	24	22·8
Newcastle ...	27	27	28	25·9	25·2
Morpeth	18	19	23	24·4	
Carlisle	24	23	24	23·2	
Newport	24	22	21	21·8	
Cardiff	22	23	21	19·8	19·6
Swansea	19	20	22	22·4	
Anglesea	17	19	21	20·6	
Derby	24	24	23	21·3	16·5
Lincoln	21	20	21	21	
Leicester	27	25	26	24·5	16·9
Guildford ...	19	19	20	19·4	
London	25	24	24	22·4	17·4
Welsh districts ...	20	21	21	21·1	
Surrey	18	18	18	16·8	
Kent	21	20	20	17·8	
Hampshire ...	20	20	20	18	
Alnwick	19	19	20	19·6	

ANNUAL RATES OF MORTALITY.

Per **1,000** living, in the **28** large Towns of England grouped in the Registrar-General's weekly Reports, arranged in order from the lowest, 1884 to 1889 inclusive.

COMPILED FROM THE REGISTRAR-GENERAL'S REPORTS.[1]

1884.		1885.		1886.		1887.		1888.		1889.	
Brighton	18·0	Brighton	17·1	Brighton	17·1	Brighton	16·9	Brighton	16·0	Brighton about	16·0
Bristol	18·4	Hull	17·2	Derby	18·2	Derby	17·1	Derby	16·3	Derby	16·5
Derby	18·4	Bradford	17·7	Hull	18·8	Nottingham	18·7	Hull	16·4	Leicester	16·9
Portsmouth	19·4	Derby	18·1	Bradford	19·1	Hull	19·2	Bristol	16·9	Nottingham	17·1
Birkenhead	19·6	Birmingham	19·3	Birkenhead	19·1	Portsmouth	19·4	Bradford	17·1	London	17·4
Huddersfield	19·6	Birkenhead	19·5	Bristol	19·3	Leicester	19·5	Nottingham	17·3	Bristol	17·5
Bradford	20·1	Portsmouth	19·7	Sunderland	19·5	London	19·5	Birkenhead	17·8	Birkenhead	17·8
London	20·3	Bristol	19·7	Huddersfield	19·6	Birmingham	19·7	Birmingham	17·8	Portsmouth	18·1
Plymouth	21·0	Halifax	19·7	Sheffield	19·8	Sunderland	19·7	Sunderland	18·1	Norwich	18·4
Hull	21·1	London	19·7	London	19·9	Bradford	19·9	Leicester	18·3	Huddersfield	18·6
Norwich	21·2	Leicester	19·8	Birmingham	19·9	Bristol	20·4	Huddersfield	18·5	Birmingham	18·7
Birmingham	21·4	Nottingham	19·9	Leicester	20·2	Norwich	20·4	London	18·5	Bradford	19·2
Leicester	22·1	Leeds	19·9	Nottingham	20·4	Halifax	20·9	Portsmouth	18·8	Cardiff	19·6
Salford	22·3	Huddersfield	20·1	Leeds	21·9	Birkenhead	20·9	Halifax	19·4	Hull	20·2
Sheffield	22·4	Wolverhampton	20·2	Salford	22·1	Leeds	21·0	Norwich	20·2	Oldham	20·4
Nottingham	22·9	Norwich	20·3	Wolverhampton	22·2	Bolton	21·3	Liverpool	20·3	Salford	20·5
Sunderland	23·1	Sheffield	20·7	Newcastle-upon-Tyne	22·2	Sheffield	21·5	Oldham	20·3	Wolverhampton	20·6
Newcastle-upon-Tyne	23·1	Bolton	20·8	Cardiff	22·6	Wolverhampton	21·6	Sheffield	20·5	Sheffield	20·9
Wolverhampton	23·4	Salford	21·1	Halifax	22·7	Cardiff	21·9	Cardiff	20·5	Halifax	21·5
Halifax	23·4	Blackburn	21·8	Oldham	22·8	Salford	22·1	Leeds	20·6	Liverpool	21·6
Blackburn	24·1	Oldham	22·0	Bolton	23·1	Plymouth	22·7	Newcastle-upon-Tyne	20·6	Bolton	22·0
Bolton	24·1	Plymouth	22·3	Norwich	23·3	Huddersfield	22·9	Wolverhampton	20·7	Leeds	22·0
Leeds	24·2	Liverpool	23·8	Plymouth	23·5	Liverpool	23·7	Salford	21·1	Sunderland	22·8
Cardiff	24·4	Sunderland	23·8	Portsmouth	23·7	Oldham	23·0	Bolton	21·6	Plymouth	25·2
Oldham	24·5	Cardiff	25·7	Liverpool	23·8	Newcastle-upon-Tyne	25·2	Plymouth	22·3	Newcastle-upon-Tyne	25·2
Liverpool	25·2	Newcastle-upon-Tyne	26·1	Blackburn	25·5	Blackburn	25·5	Preston	23·9	Blackburn	25·5
Manchester	26·4	Manchester	26·5	Manchester	26·3	Preston	27·9	Blackburn	23·9	Manchester	27·2
Preston	27·3	Preston	27·1	Preston	28·9	Manchester	28·6	Manchester	26·1	Preston	30·0

In England the Death-rate for 1861–70 was 22·5.
" " for 1871–80 was 21·5.
" " for 1881 was 18·9.
The Zymotic-rate was 3·36, 4·11, and 2·24 in the same period.
The Fever-rate was 0·49, 0·88, and 0·27 " "

[1] Some important modifications of this table are requisite to correct for population according to the recent census.

In Bradford the course of reduction of death-rate will be seen from the following table—

				Zymotic.
1864	30·6	1875	27·1	6·8
1865	27	1876	23·9	4·73
1866	27·3	1877	21·9	3·15
1867	24·5	1878	22·5	4·24
1868	26·6	1879	21·1	3·10
1869	25·6	1880	20·9	4·38
1870	27·7	1881	19·6	2·64
1871	25·5	1882	21·3	3·92
1872	25·7	1883	18·3	2·1
1873	24·4	1884	20·	3·34
Mean of ten years 1865—1874	26·3	1885	17·7	
		1886	19·1	
		1887	19·9	
		1888	17·1	
		1889	19·2	

The rate for typhoid fever for the five years 1874—1879 was 2·52 per 1000; for 1879—1884 only 1·88 per 1000. Pneumonia diminished 8·1 per cent., but bronchitis scarcely at all. The rate of consumption fell by about 20 per cent.[1]

In Birmingham a similar reduction of the death-rate took place, and also in Leeds and Salford. In Birmingham from 1865 to 1875 the highest death-rate was 26·8 and the lowest 23; from 1875 to 1885 the highest was 25·2 and the lowest 19·1; from 1886 to 1889 the rates have been 19·6, 19·4, 17·8, 18·7. The zymotic rate has declined fron 5·6, 7·3, 5·9, in 1873, 1874, 1875, to 2, 3·2, and 3 in 1885, 1886, and 1887.

In Glasgow the mortality has been as follows:

Mean Annual deaths :—	1871—1875	...	15,400
„ „ „	1876—1880	...	13,451
„ „ „	1881—1885	...	13,531

Lives saved in last ten as compared with first five years, 19,090.

[1] Report for 1884 by Dr. Hime, with Retrospect of ten years.

Glasgow		Typhus	Enteric	Small-pox	Scarlet Fever	Measles
1871—1875	...	136	228	158	753	445
1876—1880	...	52	202	4	268	285
1881—1885	...	32	156	5	334	383

Glasgow		Diphtheria, Croup	Diarrhœal	Consumption	Acute Lung
1871—1875	...	312	464	1936	3391
1876—1880	...	282	371	1725	3135
1881—1885	...	292	352	1562	3103

In Leicester, Bristol, and Brighton, rates have been given, slightly differing from those in the above tables :

	Leicester.	Bristol.	Brighton.
1876	24·1	23·1	19·7
1877	22·6	22·5	18·8
1878	22·1	22·2	21·3
1879	23·2	21·9	19·1
1880	25	21	19·8
1881	21·8	19·6	19
1882	20	19·2	21·7
1883	19·2	17·9	19·2
1884	22·1	18·4	17·9
1885	19·4	19·7	17·1
1886	20·2	19·3	17·1
1887	19·5	20·4	16·9
1888	18·3	16·9	16
1889	16·9	17·5	?

Among places which have reduced their death-rate to a remarkably low point may be mentioned : Sandown, of which the rates were as follows, from 1881 to 1888, 7·7, 13·4, 15, 10·9, 8·9, 8·6, 10·3, 11·2 ; Llandudno, of which the rates were 15·3 in 1881, and 10·8 in 1888 ; Hythe, of which the rates from 1880 to 1888 were 17·2, 13·1, 13·5, 9·9, 12, 10·5, 12·6, 11·1, 14·3 ; Hastings, which in 1888 had a rate of 13·1, and a zymotic rate of 0·4 ; Eastbourne, which in 1888 had a rate of 12·8 ; and Saltburn, which had a rate of 12·1 in 1888, and no death from zymotic disease. At Tunbridge Wells the rate for some years has been about 14, and the zymotic rate from 1885 to 1888 was only 0·6. Here there is a pure water-supply, the drains are flushed and cleansed, and there is an isolation hospital.

In the town of Bath the death-rate has been as follows since 1856—

1856	19·9	1871	23·1	zym. 2·2
1857	21·3	1872	22·6	2·6
1858	27·3	1873	24·2	1·4
1859	23·7	1874	23·2	1·2
1860	22·9	1875	24·9	0·9
1861	22	1876	21·2	3·3
1862	22	1877	22·5	2·1
1863	24	1878	23·4	1·4
1864	27·4	1879	21·07	1·5
1865	25·3	1880	20·4	1·9
1866	23·4	1881	19·04	0·9
1867	22·4	1882	20	0·6
1868	21·56	1883	22·6	0·8
1869	21·22	1884	20·7	1·1
1870	25·3	1885	21·4	0·5
		1886	21·1	0·4
		1887	17·7	0·3

The decline of the zymotic rate is remarkable in this town. Dr. Brabazon lays stress on the very common spread of infection by children attending school, on the immense importance of the Statutory Hospital, and on the great benefits of improved water-supply. "Were I asked in what direction sanitary efforts have produced the most beneficial and permanent results in the past year, I should say in the supply of water." (Report for 1880.)

With regard to scarlet fever, "the disease has appeared in districts far apart, but I might say in almost all cases the occurrence has been traced to the conveyance of infection." "The mortality among those treated in their own homes was 22·1 per cent., and among those treated in Hospital 4·5 per cent." In 1883, 105 cases of scarlet fever were admitted to the hospital, and *no* death occurred, but five occurred outside.

Bathwick Hill formerly drained into cesspools, with the consequence that fever was almost chronic.

In Malvern the death-rate has been kept very low by the situation of the town, the way in which the houses are built, detached and surrounded by open spaces, the careful disposal of drainage, the excellent water, and by notification and systematic supervision.

Out of a population of about 6000 there were in 1882, 62 deaths; in 1883, 71; in 1884, 64; in 1885, 68; and in 1886 the rate was 12·16 per thousand; in 1887, about 10·6; in 1888 there were two deaths from enteric fever, both imported. In 1889 there was one case of typhoid, imported, and the death-rate was 12 per 1000.

Derby is greatly distinguished for its life-saving action during the last few years, and now takes a place at the head of the list of large English towns, if Brighton be excluded. The Medical Officer informs me that he attributes this comparative immunity from disease to the methodical and regular manner in which the sanitary work of the borough is carried out, and the performance of duties as recommended by authorities on sanitation. A good Committee and hardworking and interested Chairman have, in spite of many difficulties and a not satisfactory condition of the river and of many streets and buildings, kept Derby in very much higher health than that of most of our northern and midland towns.

The following tables will explain themselves:

1877.

London, Surrey side; Population, 742,155.
Surrey, extra-metropolitan, 365,279.

	Small-pox	Measles	Scarlet Fever	Diphtheria	Whooping Cough
Surrey (London)	678	557	350	86	492
Surrey (extra-metropolitan)	50	94	65	90	123

	Typhus	Typhoid	Cholera	Respiratory	Total
Surrey (London)	59	252	25	3695	6194
Surrey (extra-metropolitan)	14	89	4	932	1461

Kensington, compared with other London Districts.

Death-rate for	1873	1874	1875	1876	1877	1878	1879
Kensington	18·3	19·5	19·4	19·5	17·3	20·3	19·1
All London	22·5	22·5	23·7	22·3	21·9	23·5	23·3
West Districts	20·5	20·9	22·1	21	19·1	21·6	22·4
North "	21·2	21·8	22·3	21·4	21·8	22·3	22·7
Central "	25	25·6	26	24	24·1	24·9	25·2
East "	25·2	25·4	25·5	24	24·4	24·9	25·8
South "	22	21·5	24	22·1	21·3	24·2	24·2

Death-rate for	1880	1881	1882	1883	1884	1885	1886
Kensington	18	16·6	16·2	15·5	15·1	16·1	15·9
All London	22·2	21·2	21·4	20·4	20·3	19·7	19·9
West Districts	19·9	19·5	19·9	19·5	19·2	19·2	19·2
North "	21·2	20·6	19·7	19·1	19·1	18·5	18·1
Central "	23·2	23	23·9	23·2	23·8	23	23·6
East "	24·3	24·2	25·3	24·1	23	22·5	23·3
South "	22·8	20·4	20·7	19·4	19·8	18·5	19·1

Death-rate for	1861–70	1874	1875	1876	1877
West Sussex	17·36	14·9	17·29	15·5	15·3

Death-rate for	1878	1879	1880	1881	1882
West Sussex	14·9	11·8	14·9	13·9	14·3

From *Transactions Sanitary Institute*, Dublin, pp. 104-6.

Rate per 10,000 for ten years, 1871—1880. Towns of over 10,000 population compared with country districts.

	Town	Country
Small-pox	3·8	0·5
Measles	3·2	1·7
Scarlet fever	6·5	3·5
Diphtheria	0·8	0·6
Fever	7·2	5·1
Phthisis	27·7	16·4
Respiratory	38·4	22·6

From *Transactions Sanitary Institute*, 1883—1884, p. 115.

Glasgow, 20 years.	Cases of typhoid,	1861—1880 ...	200,000
	Deaths ...	1861—1870 ...	18,700
	Deaths ...	1871—1880 ...	70,80

TYPHOID DEATHS PER MILLION.

	Before Sanitn.	After Sanitn.
Bristol	1000	650
Leicester	1460	770
Croydon	1500	350
Merthyr	2100	860
Edingburgh	540	326
Glasgow	1240	435
Dantzic	700	74

From *Transactions Sanitary Institute*, Bolton, 1887—1888.

	Death-rate	Proportion of zymotic to total deaths per cent.		Death-rate	Proportion of zymotic to total deaths per cent.
1867 ...	29	24·9	1877 ...	23·5	18·7
1868 ...	25	21·6	1878 ...	22	21·5
1869 ...	26·7	16·4	1879 ...	21	11·8
1870 ...	27·3	19·3	1880 ...	20·5	24·4
1871 ...	26·1	20·6	1881 ...	19·1	13·3
1872 ...	28	23·5	1882 ...	21·3	19·3
1873 ...	23·3	20·8	1883 ...	19·9	10·3
1874 ...	24·3	19·1	1884 ...	24	18·2
1875 ...	26	20·3	1885 ...	20·7	9·2
1876 ...	23·6	15·5	1886 ...	23·1	15·9
	25·9	20·2		21·5	16·2

In Bolton, new waterworks came into operation in 1885.

This town uses the dry earth system largely, and has had notification since 1877.

Death-rate for	Glasgow	Edinburgh	Dundee	Aberdeen[1]	Greenock	Leith	Paisley	Perth
6 yrs.—1855—1860	29·9	24·2	27·2	23·9	30·5	22·5	26·9	25
10 yrs.—1861—1870	30·4	25·8	28·4	24·4	31·3	23·7	27·8	25·4
10 yrs.—1871—1880	28·6	23	25·5	21·7	27·3	22·5	27·8	22·7
7 yrs.—1881—1887	25·6	19·3	20·8	20	21·1	18·6	24·5	18·7
44 wks. ending Nov. 3 —1888	22·2	18·4	18·2	18·2	14·6	15·8	24·5	17·9

[1] Waterworks increased, 1888.

"HEALTH RESORTS."

Medical Recorder, Holiday Number, 1889.

	Aberystwyth	Blackpool	Bognor	Brighton	*	Broadstairs	*	Budleigh Salterton	Buxton[1]
1882	17.5			21·6		17·7	* 1·3	14·5	12·7
1883	14	16·6	15·4	19·2		16·7	1·1	15·1	9·9
1884	14	17·1	15·4	18		20·1	2·2	16·6	11·6
1885	15·5	15·2	16·4	17·1		18·2	1·8	17·1	9·1
1886	13·1	16·5	15·1	17·1		21·8	1·8	21·7	9·8
1887	14	14	12·4	16·9	* 1·1	17·2	0·4	16·1	9·7
1888	16	13·2	14·7	16	1·3	15·1	1·3	21·5	14·3

	Cromer	Dawlish	Deal	Dover	*	Eastbourne	Exmouth	Felixtowe & Walton	*	Folkestone
1881		17·8	16			12·93				
1882		19·4	15·5			14·73	18·5			
1883		18	15·7	16·6		14·8	16·2			
1884	18	17·7	22	18·7		13·1	14·7			Av. D. R. of 10 years: 16·4
1885	15	17·5	16·2	17·6		14·1	20·3			
1886	11	19·5	16·6	18·8		16·2	19·6			
1887	18	19·5	14·8	17·7		13·1	15·1	5·8	*	
1888	14	17·2	13·5	16·3	* 1·1.	12·8	18·2	11·1	·57	13·17

	Gt. Yarmouth	Harwich Dovercourt	*	Hastings[2]	*	Herne Bay	*	Hunstanton
1881	19·23			15·6	* ·9	18·4	* 2·1	
1882	20·2			16·1	2	17·3	1·4	
1883	19·1	12·6	* 0·9	15·8	0·7	12·9	1·4	
1884	21·3	14·6	1·5	15·9	1·8	18·5	3·4	about 12
1885	19	13·7	·2	14·2	1·2	18·7	1	18
1886	22·4	10·9	·2	14·0	1·4	16·9	4·4	16
1887	20·1	12·6	1	14·5	1·4	16·6	0·6	10
1888	20·2	10·7	·9	13·1	0·4	12·4	1·2	11

	Hythe	*	Ilfracombe	Ilkley	Sandown[3]	Ventnor[4]	Leamington	Llandudno	Llanfairfechan
1880	17·2	* 0·4							
1881	13·1	0·2			7·7	18·3		15·3	
1882	13·5	1·9			13·4	22·6		12	15·7
1883	9·9	0		13·6	15	20		14·6	15·3
1884	12	0·4		16·4	10·9	18·3		12·1	18·6
1885	10·5	0		13·2	8·9	18		12·9	19·9
1886	12·6	1·8	14·1	13·4	8·6	23	16·9	14·7	21·2
1887	11·1	0·2	19·7	15·8	10·3	18	15·4	15·8	13·5
1888	14·3	0·6	14·3	12	11·2	12·8	18·3	10·8	14

[1] Excluding Visitors. [2] *Ibid.* [3] Not excluding Visitors. [4] *Ibid.*

* Zymotic.

	Morecambe	New Brighton	N. Berwick	Ramsgate	Rhyl[1]	Saltburn[2]
1880				19·1		
1881	21·62	16·4		16·3		
1882	19	19		17·9		
1883	16·5	17·1	13	16·2		13·5
1884	16	16·1	18	18·8		12
1885	18·5	14·9	13	16·8		13·9
1886	21·1	15·1	15	18·1	14	10·4
1887	16	17·7	11	15·9	16·4	7·3
1888	14	14·4	15	15·5	13·9	12·1[3]

[1] Excluding visitors and public hospitals.

[2] *Note as to Saltburn.* Good fall for drainage. Streets and drainage new and efficient. Ventilated into street. Water pure. No wells. House to house inspections.

[3] No Zymotic in 1888.

	Scarborough[1,2]		Seaford	Southend[3]	Southsea[4]		South Shields	Residential portion.
1880	20	* 2·1						
1881	16·3	0·8					18·1	
1882	18·2	1·6					20·2	12·6
1883	18·8	1·3			13·8	* 1·1	20·9	12·3
1884	17·3	1·8		14·8	14·7	0·7	22·1	12·1
1885	16·6	0·7	14·1	19·3	14·5	1	22·3	14·9
1886	18·4	1·4	20	15·4	13	1·4	20·5	10·5
1887	16·6	0·8	14·6	15	12·2	0·6	20·7	17·1
1888	15·6	0·6	15·2	15·7	10·1	0·4	18·1	9·1

[1] On permanent population.

[2] *Note as to Scarborough.* Inspection and certification of houses. Register of houses and defects kept at Town-hall, always open to inspection. Hospital for infectious cases. Disinfecting apparatus.

[3] Including visitors.

[4] *Southsea.* Excellent water. Drains disconnected and ventilated. Hospital.

	Southwold[1]	Teignmouth[2]	Torquay[3]	Tunbridge Wells[4]		Tynemouth[5]		Weymouth
1881		14·9		14				
1882		15·7		15·4		16·3	* 1·3	
1883		17·5	16·9	14·6		16·3	0·9	
1884	12·4	17	15·4	15·7	*	14	0·9	16·7
1885	11·5	16·1	15·8	15·4		15·1	1·2	17·2
1886	13	18	16·4	14·4	0·6	19·6	1·2	17
1887	16·8	16·6	13·3	13·4		19·2	2	15·2
1888		16·1	16·3	14		17·1	1·1	17·8

[1] *Southwold.* No drainage, etc.

[2] *Teignmouth.* Entire sewerage new, flushing-tanks, ventilation. Model bye-laws adopted.

[3] *Torquay.* Including visitors. Very low zymotic death-rate, about 0·7.

[4] *Tunbridge.* Pure water, flushing, cleansing, isolation in hospital.

[5] *Tynemouth.* Hard water.

	Whitby		Worthing			Whitby		Worthing	
1881			15·3	* 1·1	1885	20·6	* 3	13·6	* 0·9
1882			13·8	1·2	1886	14·9	1·3	17·2	4·8
1883	17·5		13·4	1·2	1887	15·5	1·6	17·3	0·7
1884	17·1		16·2	1·5	1888	15·1	1	15·9	1·3

DEATH-RATE OF ENGLISH WATERING-PLACES, YEAR ENDING JUNE 1889.

Sanitary Record, July 1889.

Aberystwyth	13·9	* 0·8	Weston super Mare	12·7	* 0·6
Blackpool	17·9	2	Weymouth	13·8	0·1
Brighton	14·8	1·1	Worthing	12·2	0·4
Dawlish	15·6	0·9	Yarmouth	19	2·3
Exmouth	16·6	—	Bath	17·3	0·5
Folkestone	14	0·8	Cheltenham	16·8	1
Hastings & St. Leonards	11·7	0·3	Clifton	10·6	0·7
Ilfracombe	14·4	—	Harrogate	13·8	0·5
Littlehampton	14·4	0·7	Leamington	16·7	1·5
Lowestoft	15·3	1	Matlock	15·8	—
Penzance	17·5	0·3	Tunbridge Wells	13·9	0·6
Sandown	13·3	0·3			
Shanklin	17·4	—			
Sidmouth	12	—	Average	15	0·9
Torquay	14	0·3			

SCARLET FEVER HAS DIMINISHED YEAR BY YEAR FROM 1875 TO 1886.

Rate, 1851–60, 88	per 100,000	1871–75, 75·8	per 100,000
1861–70, 97	„	1876–80, 67·9	„
1871–80, 72	„	1881–85, 43·4	„
1886 17	„		

DIPHTHERIA DEATH-RATE, ENGLAND AND WALES.

1871–75, 12·1	per 100,000	1881–85, 15·6	per 100,000
1876–80, 12·2	„		

PHTHISIS DEATH-RATE ENGLAND AND WALES. MORTALITY PER *million.*

1851–60, 2679 1861–70, 2475 1871–80, 2116

CHOLERA, ENGLAND AND WALES.

Epidemics.	Deaths.
1849	53,293
1854	20,097
1866	14,378

Since that time Cholera has never succeeded in establishing itself in England.

MATERNITY HOSPITALS, AND SURGICAL CASES.

Dr. Lefort, having collected statistics of 888,302 hospital deliveries and of 934,781 home deliveries, found mortality in hospital 35 per cent, at home 4·75.

Also mortality after operations found by Sir James Simpson as follows:

In large Paris hospitals with more than	600 beds,	deaths	620	per 1000.
„ English „ „	301 to 600	„ „	410	„
„ „ „ „	201 to 300	„ „	300	„
„ „ „ „	101 to 200	„ „	230	„
„ „ „ „	25 to 100	„ „	140	„
Isolated rooms in country practice	...	...	108	„

Since these figures were published a very large reduction in hospital mortality has been effected by antiseptic and sanitary methods.

Sanitary Record, May 16, 1887.

MUNICH STATISTICS, SHOWING EFFECT OF SANITARY IMPROVEMENTS.

	Per 100,000.	Per 100,000.
Typhoid ...	1850–52, 242	1877–79, 79
	1860–67, 166	1880–84, 23
	1868–75, 127	
At Breslau ...	1863, 150	1880, 40
	1870, 60	1882, 30

FROM TRANS. SANIT. INSTIT. 1885–6.

	Population.	State of drains and water.	Death-rate. Before Sanitary works.	Death-rate. After Sanitary works.[2]
Aix-la-Chapelle	90,000	Part improved	29·86	28·02
Basle ...	69,000			
[1] Berlin ...	1,263,000	Begun 1873, not finished. 286 miles sewers	31·73	29
Bochom ...	40,000	From 1875. House drains disconnctd.	34·41	30·89
[1] Brussels ...	165,000	30 years water-carriage.	31 ('65–'71)	23 ('71–'80)
[1] Dantzic ...	90,000	... ...	36·51	28·66
Dortmund ...	...	... ...	34·37	27·65

[1] In these towns water-carriage drainage in its entirety. [2] Mostly incomplete or partial.

Dresden	...	... 28·74	25·27
Erfurt	...	... 29·39	24·2
[1] Frankfort	...	... 17·92	20·64 [2]
Halle	...	... 30	25
Heidelberg	...	... 27·04	23·18
Hamburg	...	... 22·86	21·98
[1] Munich	...	... 36·9	31·4
Paris	Drains and cesspools	29·75	24·28
[1] Rotterdam	Water-carriage	33·9	23·8
[1] Linz	Water-carriage	42·9	32·73

BOSTON, U. S. RESULTS OF SEWERAGE.

Old System of Sewerage.

	Year	Deaths per 1000.
	1881	26·87
	1882	25·30
	1883	25·19
New System.		
In operation early in	1884	23·67
	1885	19·53
	1886	17·73

Zymotic diseases decreased very much: from 2551 deaths per annum to 1644 in 1886. Diphtheria from 436 to 329. Scarlatina and measles reduced largely.

Most of the instances of reduction of mortality in the above tables show the effect of improvements in water-supply, drainage, and scavenging. The towns of lowest mortality, such as various seaside and inland resorts, show the effect of these improvements, and of abundance of air-space, in houses, and in proportion to population. It is in the increase of air-supply, cubic space per person, and ventilation, that further increase of health in town and country is mainly to be sought.

[1] In these towns the water-carriage drainage in its entirety.

[2] The increase at Frankfort due to new rules and great immigration.

TABLE OF MODES OF ORIGIN AND SPREAD OF ZYMOTIC AND INFECTIOUS DISEASES.

Diseases.	Arising from	Spreading by
Malaria, intermittent fever, ague, dysentery.	Water-logged or recently flooded soil containing organic matter, and of a certain composition and perhaps salinity. Use of water in soil especially infested by the malarial microbe. Emanations; especially when concentrated about sunset near the surface of the earth, from soil of an appropriate composition and temperature, these emanations containing micro-organisms possibly in the form of spores. Water not far from the surface seems to be necessary for the maintenance of these organisms at a small depth. Dust from a spore-bearing surface seems to be strongly capable of infecting the human body.	Possibly these diseases, especially dysentery, are sometimes spread by infection of drinking-water, etc., by discharges from previous cases. Otherwise they are not apparently infectious from person to person. But it appears that persons affected with malaria have introduced and planted the disease upon the soil of places before exempt.
Cholera, typhoid.	Excreta, filth-contaminated water, milk, food, clothing. The typhoid bacillus grows well in unflushed, ill-ventilated drains, in the water of wells, and in milk. The cholera bacillus exists in the polluted soil and tanks of parts of India.	Polluted water, milk, and food, and growth on decaying organic matter and filth, whence it infects the air or water, and so passes to fresh masses of filth or to water-supplies, where it multiplies potently. The discharges of the sick are the main source of danger. Dirty people, and also animals, convey it from place to place by innumerable means. In dry countries clouds of dust from dirty surfaces carry the particles to tanks and wells.
Rabies	Bites of rabid animals. Original evolution unknown, but probably offal or filth evolved the specific microbe.	Bites of rabid animals.
Typhus, diphtheria, scarlet fever, whooping-cough, small-pox, measles, influenza, dengue, yellow fever, pneumonia, erysipelas	Filthy, low, and crowded places. Drains. Heaps of refuse and manure. Dirty soil-surface and floors, walls, etc. *The breath and emanations of patients.* Infected articles of clothing, bedding, furniture, etc. Several of these diseases extend to man from diseases in domestic animals, occurring through negligence, filth, and overcrowding.	The breath and emanations from the patient; in some cases, probably most, the microbes settle on various articles, especially clothing, and are conveyed alive to fresh subjects. Susceptible persons are infected by persons who have been with the sick, and by goods or articles on which the germs have settled.

Diseases.	Arising from	Spreading by
Tuberculosis ... (phthisis, consumption).	Foul air and soil and unventilated crowded rooms, cow-sheds, etc. The sputum of those affected, or of previous unobserved cases, infecting the air and food or milk in close places. Possibly the microbe arises from some damp soils, but is only capable of harm in bad air. Milk, etc. from tuberculous cows.	Foul air conveying the microbe and enabling it to survive on carpets, walls, etc., whence it infects when dry. Is breathed in and infects delicate or damaged lungs or skin. Also infects through milk from tuberculous cows, and through badly-cooked flesh from diseased animals.

INCUBATION PERIODS.

Cholera	1 to 5 days.
Consumption ...	Ill-defined.
Catarrh	A few hours to 1 day or 36 hours.
Dengue	About 3 days.
Diphtheria	3 or 4 to 6 or 8 days. Occasionally 1 or 2 days.
Influenza	1 to 5 days, or occasionally longer or shorter.
Measles	7 or 8 to 18 days.
Mumps	14 to 22 days.
Malaria	A few days to a few weeks or months.
Plague	2 to 5 days.
Relapsing fever ...	2 to 12 days. Some cases occur almost immediately after exposure to concentrated infection.
Rötheln	10, 14, to 21 days.
Rabies	14 days to 3 months or more. Pasteur's strongest virus 7 days certain.
Scarlet fever... ...	2 to 8 days.
Small-pox	12 to 15 days. By inoculation 7 to 9 days.
Typhus	Average, 12 days.
Typhoid	Average, 11 days. 5 days has been noted, from contaminated milk.
Whooping-cough ...	About 14 days.
Varicella, chicken-pox	10 to 19 days.
Vaccine	7 to 9 days.
Yellow fever... ...	2 to 8 days.

It will be seen from the above summary that places situated on a good dry soil, with a water-supply free from contamination, proper disposal of refuse, and clean drainage; with care for the health of domestic animals; with a population living in well-ventilated and uncrowded houses, exercising care in the exclusion and isolation of zymotic diseases, will be almost entirely free from these in an epidemic and even in a sporadic form, and that if able to watch and control the introduction of infection by visitors and travellers, the bulk of the inhabitants would not suffer at all from any of these maladies.

And such, in point of fact, has been the actual experience of communities which have approached these conditions most nearly. Islands rarely visited, or where the infection of a disease such as typhoid, diphtheria, and consumption has not been introduced by human agency, have remained untouched by the specific cause. (See cases of Scilly Isles and Hebrides, and St. Kilda's, Pitcairn, and Falkland Islands.) Prisons also, where isolated and managed on the best hygienic principles, are unaffected by the zymotic maladies which may be raging in the free population not far off.[1] Thus we are led to the conclusion that if any of the germs of all these diseases are borne long distances through the air without destruction, this must happen only very rarely and ineffectively. Practically, if care is taken to prevent infection by filth, by animal diseases, and by personal or domestic neglect of isolation and disinfection, most of these diseases would cease to afflict humanity. Here

[1] Some well-managed towns, though surrounded by an unscrupulous population, have been successful in keeping their rate of sickness from zymotic disease very much below the average.

and there, conceivably, a case of illness might arise in a large community the seeds of which were carried through the air from a distant part of the world, but even if such cases did rarely occur, early segregation would prevent any general epidemic. It is even probable that before other neighbouring nations had greatly reduced the prevalence of zymotic disease within their borders, no cases might be introduced to this country except through human agency and commerce.[1] If a town can be made fairly healthy in the midst of a population not so distinguished, *à fortiori* an island like our own can rise to a high degree of immunity, though surrounded by less healthy societies. Unity and scientific precision of administration would be necessary, and the communication of disease through carelessness would have to be treated as a more serious offence than at present. Not only extensive outbreaks, but every case of serious communicable disease should be made known to the Central Department of Health, and within easy reach of every division of the country a trained officer should be stationed, to see that every victim is properly cared for and prevented from dealing calamity to the neighbourhood. As filth and other expellable causes are constantly more thoroughly removed and treated, the task of extinguishing epidemic and endemic diseases will become constantly lighter, and the responsibility for any wide extension of illness will be felt to

[1] When an infectious disease, such as diphtheria, influenza, whooping-cough, or scarlet fever, crops up in a place hundreds of miles apart from any other case, it is often attributed to an atmospheric or local cause, when it may have been conveyed by one of the countless channels of commerce and the post. Influenza was thus diffused to an immense extent. In some parts of Scotland bread is delivered at distances of twenty or thirty miles from the bakery.

fall entirely upon erring human conduct, where light is abundant and the path of exemption plain.

ORIGINS OF EPIDEMICS.

The cases in which investigators have been able positively to run down an epidemic to its first starting-place, where it was cultivated, bred, and acquired as a parasite of the human body, are not very numerous. Still there are sufficient to throw a great deal of light on the first causes of plagues and epidemics in general.

It is not necessary for the purposes of prevention that the manner of evolution of the primal organisms should be known, any more than that for the extermination of wolves, or the phylloxera, or the cattle-plague, we should be acquainted with the gradual primeval development of the wolf, the phylloxera germ, and the germ of the cattle-plague.

It is sufficient if we know that in such and such preventable conditions the pest arises, and that in other conditions it does not arise.

Let the following known conditions of origin be compared.

The Plague.—The plague always arises in conditions of great foulness of soil and dwellings, especially where cattle live in the houses, where manure is heaped around, and where dead bodies are not buried at a distance, but remain in damp ground near dwellings, polluting soil and water. The ventilation in these places is usually extremely bad, and the floor and walls filthy. Once started, the plague, if of a virulent type, may spread by ordinary intercourse, but often it is confined to the neighbourhood of the polluted soil.

The Sweating-Sickness.—The origin of sweating-sickness has been attributed to the soil of Picardy, and it seems to have arisen in conditions of great filth and misery. It was first brought to England apparently by mercenaries from that part of France, in 1485.[1] They are described by Shakspeare as "a scum of Bretagnes" and "famished beggars." Whether they actually had the disease among them is uncertain, but it is a fact illustrated by many examples, that epidemics of several kinds may be introduced by persons not themselves suffering, who have been exposed to the infection and bear it in their persons or clothes. The sweating-sickness once started showed if anything a preference for the upper classes and for clean houses. It is probable therefore that it was a breath infection caught by proximity to actual cases or acclimatized persons.

Influenza.—This disease arose in 1889, in a town of Central Asia which was subject to great distress, famine, and malaria, in a hot spring when the marshes and filthy pools were rapidly drying up, and when the people were crowded together with cattle and sheep, ventilation of houses and of the town generally being hindered by the habits of the people and the walls of the city. The malaria may or may not have been an essential factor in the evolution of a virulent form of the disease. It seems not unlikely that a malarial microbe may have been at first associated with another arising specially from the filth-cultivations in the town, and that the disease may have passed through sheep or other animals, and so acquired a virulence for man. The crowding of human beings with animals is specially noteworthy. Once started, the flight of officials and

[1] *History of Epidemics in Britain.* Creighton, 1891.

convalescents to various parts of Russia gave rise to a number of centres or foci of infection, from which the pestilence spread to the rest of the world by the innumerable channels of modern communication. The breath of a patient was potent to infect many persons in proximity. The rapid spread is accounted for by the smallness and number of microbes given out from the lungs, the short period of incubation, and the susceptibility of a large portion of the population.

Shearing-shed Fever or Fog Fever.—This disease, which is very like influenza, arises when a large number of men and sheep are crowded in the shearing-sheds of Australia in hot dry weather. It occasionally spreads from the shearers to the surrounding population.

St. Kilda Influenza, etc.—This disease, which is like a severe cold or influenza, attacked the population of the island after the arrival of a boat from the mainland when communication was very infrequent. Nearly all the islanders suffered. Similar occurrences are recorded by Darwin and others of the islands of the Pacific.[1]

Darwin notes the occurrence of sickness in flocks of sheep in England, among which sheep, apparently healthy, imported from vessels, have been placed. But these sheep may have suffered from colds or some other sickness before embarkation, and retained the infective matter in their wool. Several cases of human influenza in islands are recorded, when the crews of ships, which had had influenza weeks or months before, had arrived and gone ashore.

[1] *Naturalist's Voyage*, pp. 435, 436.

Texas cattle fever in a similar way is caught from apparently healthy cattle.[1]

Yellow fever was apparently first introduced to the West Indies by the crowded cargoes of Negro slaves, the negroes themselves being racially exempt, although, perhaps, the source of the virus.[2]

Gaol fever was frequently caught by officials of the Law Courts from prisoners who brought with them the smell of the gaol, although themselves in good health.

A phenomenon of a somewhat different order perhaps is the great liability of country horses to be affected with illness on being stalled in London stables.

Darwin quotes the Rev. J. Williams as stating in his work on Missionary Enterprise, "that the first intercourse between natives and Europeans is invariably attended with the introduction of fever, dysentery, or other disease, which carries off numbers of the people."

Malaria.—Although malaria cannot be classed among plagues, its development has a distinct bearing on that of many of the spreading epidemics. According to Humboldt, "the smallest marshes are the most dangerous in the torrid zone, being surrounded with a sandy arid soil which raises the temperature of the ambient air." Darwin quotes from an "admirable paper" by Dr. Ferguson the statement that the poison is generated in the drying process. The pools and drying ground are evidently culture-grounds at a suitable temperature and moisture for microbes which are capable of thriving when transported to the dissimilar pabulum of the human blood.

Cholera.—Cholera appears to require more than the

[1] *History of Epidemics in Britain*, A.D. 664—1666. Creighton.

[2] *Ibid.*

rich organic soil or briny sand which often nourishes malaria, and the cholera bacillus thrives best on soil polluted with filth, or with corpses, in alluvial sodden land at a high temperature. Striking first the neighbouring population, the virulent strains of cholera microbes are able with suitable temperature conditions and human communications to spread to a great part of the world, growing and spreading by means of their favourite food—filth and dirty water.

The original breeding-ground of cholera is so well known that it would appear possible by reducing and controlling it there, and dealing systematically with sporadic outbreaks from the leavings of former epidemics, to prevent any great prevalence of this plague.

Epidemic Pneumonia and Typhoidal Pneumonia.—These diseases appear to arise from filth conditions similar to those which give occasion for typhoid, and several original outbreaks seem to show that if the original conditions of filth were controlled, and better ventilation secured, they would be rare maladies. For there is ground for the belief that pneumonia of certain kinds is extremely infectious, and that the germs may be conveyed on clothes, etc., and then easily attack persons suffering from other illnesses, colds, or bronchitis.

Diphtheria.—Diphtheria appears sometimes certainly to arise distinctly from foul conditions, and to require either the introduction of the germ to those foul conditions, or the presence of animals, poultry especially, which have been exposed to such conditions, before it is manifested in the human subject. The germ does not appear to be common or widespread, and by far the most usual mode of transmission is from case to case, directly or indirectly. The intensity and spread of diphtheria are immediately increased by re-breathed air, as in schools.

Unclassed Fevers, similar to Influenza, Pneumonia, Typhoid, etc.—These have been shown to arise in conditions of overcrowding, filth-charged soil, and proximity of burial-grounds, and the symptoms of epidemic outbreaks which have been carefully described by medical authorities seem to show that we may regard the crowding combined with the presence of filth-cultivated organisms as giving occasion for the development of diseases of this category.

Consumption, Tuberculosis.—This, the most fatal of diseases, may be assumed to have arisen in conditions similar to those which now most conduce to an attack. Pollution and dampness of soil and re-breathed, foul air, with organic deposits from the breath, etc., on walls and floors, may have converted a saprophytic organism into a human parasite. The disease may now occasionally arise thus *de novo*, but is most spread by human intercourse and the transmission of the microbe in uncleanly conditions and unventilated places. As in gaol fever, or typhus, the microbe colonies appear to be capable of sticking for a long time to the walls, clothes, etc., where fed by the condensation of breath and emanations. French prisons have a large mortality from consumption, to some degree owing probably to the insufficient cleansing of cells, corridors, and clothes.

Diarrhœa.—This disease, like cholera, arises from certain kinds of soil in which a particular microbe finds a nutrient habitat. At a rather high temperature and appropriate humidity, it emerges into the air in large quantities, settles on articles of food and drink, in which it multiplies, and is breathed in and swallowed. Sometimes, presumably with special virulence, diarrhœa is infectious from case to case.

Yellow Fever.—This semi-malarious disease arises like cholera from dirty, damp soil, ships, etc., to which the germs had at some previous time been brought. The places where it is acclimatized are not very many, and it is sensitive to cold, so that with proper cleansing measures, quarantine, and prevention of crowding, it could be rapidly reduced. It is at present terribly destructive at several Brazilian ports, and eighteen English captains have died at one port within a few months.

Typhoid Fever.—The places of origin of typhoid outbreaks are well known to be dirty drains, polluted soil, and wells contaminated by excremental filth. The germ may rise into the air from such places, especially from drains and heated soil. In India it prevails most when the surface of the earth is driest and at a temperature of about 72° F. With the dust raised by wind, or emanations from the earth, it may then find its way to drinking-water, or directly to the human system.

It will be observed from the above instances, and from others given in the body of this work, that the conditions of origin of plagues of various kinds lie in defective cleanliness of soil, water, and air, and in ground more or less sodden and containing stagnant water a little depth below the surface.

The same conditions, as a rule, are required for their spread to masses of a population.

The importance of a good water-supply and drainage is pretty well realized, though in many parts of the country bad water, bad cesspools, and bad drainage are commonly in use, and in towns the majority of houses are faulty and dangerous.

But what is scarcely at all realized is the importance of drainage of air. Every hour each inmate of a house, each occupant of a room, breathes out a large volume of noxious matter which ought to be carried away, but is allowed to accumulate and be deposited with organic particles on walls, floors, furniture, windows, and clothes. If these products were not practically transparent, we should be horrified at the amount of foreign matter, which is more or less poisonous, contained in a close room or railway-compartment. The smell of smoke clings to rooms and clothes, and similarly the particles of condensed vapour from the breath, and the particles of pestilent disease, if any subject of a disease such as plague, diphtheria, measles, or influenza was present, cling to the articles which have been exposed to them. The organically-contaminated water deposited on our walls from condensed breath, and the millions of microbes which live in dusty corners, produce putrefactive changes which may become evident to the senses in a stuffy room. In influenza and diphtheria the air near the patient is loaded with infectious particles exhaled. In a railway-compartment containing ten persons, with one window closed and the other slightly open, a number of microbic colonies, a hundred times beyond the average of ordinary living-rooms, were discovered by scientific tests. We look after the health of cattle better than to allow them to be shut up, packed alive as it were, in a small box, with only the slightest provision for change of air. Every evening, many thousands of people travel from London to the country after their day's work in an atmosphere reeking with the discharged effete matter from each other's lungs, and with multitudes of bacteria, mostly not a harmful kind, but certainly undesirable in large quantities. When influenza or colds are prevalent, infection becomes almost a certainty to all susceptible persons in these stuffed compartments, and the microbe passes through this reeking deoxygenized air in full vigour to attack fresh victims. During the prevalence of influenza and colds, the chances of escape are almost directly as the amount of air admitted. Yet, just at these times whole trains are seen with scarcely a chink of window open, the window-glasses covered with organic steam. If statistics were procurable, it would be found that the daily travellers by train in winter suffer from colds and lung troubles in much larger proportion than the engine-drivers and guards who get more of the outside air. All statistics of the influenza epidemic proved that those living in the stuffiest conditions were most attacked. Habitual life in the open air does not protect a man who happens to be brought into proximity to an infectious case for a few minutes in a crowded place, but it contributes largely to habitual health.

Water and soil have had a good deal of attention bestowed upon them, and great engineering works have been accomplished to secure them from gross contamination. The purity of air is certainly not less important. With attainable purity of air and cleanliness of dwellings a great class of spreading diseases, including consumption, would decline and become rare.

In times of threatening epidemic, there would be much advantage if a population exposed to its attack could be induced to wear waterproof or washable clothing, which could be daily cleansed with soap and water. A serviceable anti-infection dress for common use and a transparent guard for the head, in the sick-room, are needed.

CONCLUSION.

On reviewing the chief causes of epidemic and transmissible disease in this and other countries, indeed among mankind generally, we see clearly that three main conditions give rise to these maladies. These conditions are—

1. Flooded, marshy, or water-logged soil.

2. Filth and decaying organic matter, on the surface of the earth, in houses, in water, and in air, in connection with human agency.

3. Contagion or infection from the sick to the healthy.

The first condition is that which gives rise to malaria, ague, catarrh, and perhaps some less common forms of fever. The second condition, either alone, or in combination with the first, gives rise to cholera, typhoid fever, the plague, yellow fever, diphtheria, some very severe forms of fever, typhus, tuberculosis, and probably dengue and influenza. Scarlet fever, measles, mumps, small-pox, chicken-pox, and German measles were also very probably originally caused by the development of an organism on filth, and may possibly still occasionally arise in the same way, or from certain seeds falling upon highly favourable soil. The third condition is that which gives the epidemic character to cholera, typhoid fever, the plague, yellow fever, diphtheria, typhus, scarlet fever, measles, small-pox, mumps, whooping-cough, influenza, dengue, erysipelas, the sweating sickness, and other maladies.

The means of prevention of these diseases are chiefly the following, broadly stated—

1. Drainage of land, and precaution against floods.

2. Cleanliness and dryness in the house and its surroundings, provision for pure water-supply, ventilation, ample space in dwellings, prevention of overcrowding, rapid and cleanly disposal of filth, and similar care for domestic animals. National provision against distress.

3. The most careful isolation of the sick, and disinfection. National and local defences against importation.

We have seen that the conditions favourable to spreading disease in timber and in plants are dampness, lack of light and of ventilation, and the proximity of unaffected to affected material; plants become diseased owing to organic decay in the close neighbourhood, and infection thence by living organisms. But there appears to be no doubt that the seeds of some plant diseases are capable of being carried great distances alive through the air, and of setting up the disease in a fresh plantation. Plants are very liable to wounds and damage by frost, wind, insects, etc., and thus present many opportunities for infective material to gain an entrance to their system.

Among animals, diseases of a spreading kind usually arise from somewhat analagous conditions, in which damp, decay, and stagnation are largely concerned. Among the most common causes of disease in cattle may be mentioned, ill-lighted and ill-ventilated stalls, the proximity of organic putrefaction and filth, befouled earth, water, and air, and the proximity of sick to healthy cases. Infected matter gains an entrance to their system by the delicate lining of air-passages and intestines. The number of diseases, and the amount of sickness, is very much greater among domesticated than among wild animals, and even those epizootics which now occur among wild animals are largely due to infection from cases among animals under human control. The reasons for this exemption are mainly, pure air, and habits of moving from place to place, so that the poisons of filth are avoided; dissociation of the healthy from the sick; survival of the strongest; and instinctive avoidance of recently-flooded areas and marshy valleys, which, as we have seen, give rise to destructive pestilence among animals as among human beings.

Among mankind the number and amount of epidemic, and many other, diseases is largely increased by the stress of civilization and by its luxuries; by aggregation, and by withdrawal from the wholesome influence of light, air, and exercise. Effete matter collects round the dwelling, in the air of the crowded room or city, and in the body of the sedentary citizen, and many opportunities occur of imbibing the germs of disease by proximity to infective cases. The minute agent of disease therefore finds polluted soil in which it thrives; polluted wells in which it thrives; polluted and confined air in which it preserves its virulence much longer than in pure air or active oxygen; enfeebled and loaded blood in which it thrives; and close aggregations which give it the power of extending its ravages over large numbers of people within a period according to its striking distance and time of incubation.

These conditions of increased disease all admit of remedy. And to so great an extent are they curable, that even in a single generation, and even in an urban district, a community may be raised to and kept at a comparatively high degree of health. Many instances of signal improvement in public health have been given in the preceding pages.

Sir John Simon has told us what are the evils to avoid. In 1874 he wrote—"There are houses, there are groups of houses, there are whole villages, there are considerable sections of towns, there are even entire and not small towns, where general slovenliness in everything which relates to the removal of refuse-matter, slovenliness which in very many cases amounts to utter bestiality of neglect, is the local habit: where, within or just outside each house, or in spaces common to many houses, lies for an indefinite time, undergoing fœtid decomposition, more or less of the putrefiable refuse which house-life, and some sorts of trade-life, produce . . . sometimes lying bare on the common surface; sometimes unintentionally stored out of sight and recollection in drains or sewers which cannot carry them away; sometimes held in receptacles specially provided to favour accumulation. . . . And with this state of things, be it on large or small scale, two chief sorts of danger to life arise: one, that volatile effluvia from the refuse pollute the surrounding air and everything which it contains; the other, that the liquid parts of the refuse pass by soakage or leakage into the surrounding soil, to mingle there of course in whatever water the soil yields, and in certain cases there to yield the deadliest pollution of wells and springs. To a really immense extent, to an extent indeed which persons unpractised in sanitary inspection could scarcely find themselves able to imagine, dangers of these two sorts are prevailing throughout the length and breadth of this country, not only in their slighter degrees, but in degrees which are gross and scandalous, and very often, I repeat, truly bestial."

Since the year in which the above was written, certain towns and districts, unfortunately only a few, have advanced a long way on the path of sanitary reform pointed out by those who had discovered the lairs and haunts of disease, and the testimony of these few is uniform to the effect that with cleanliness, with prevention of crowding, and with isolation and disinfection, a very large reduction in the yearly amount of suffering by sickness and death is absolutely secure. Other localities, much more numerous, have gone slowly, tentatively, and hesitatingly, some little distance along the same path, and in these the saving of health and life is proportionately moderate.

"One principle," said Sir John Simon,[1] "is at the root of all practice which ought to be adopted in the various cases of infectious disease. This principle . . . is the thoroughly effective separation of the sick from the healthy—a separation which, so far as the nature of the disease requires, must regard not only the personal presence of the sick, but all the various ways, direct and indirect, by which infective matter from that presence may pass into operation on others. . . . It is likewise essential that all who attend on the sick should be careful not to carry the contagion to other persons, as they may but too easily do."

The facility with which infective matter is distributed is much greater than is generally recognized. In diphtheria, influenza, small-pox, erysipelas, yellow fever,

[1] *Public Health Reports*, Vol. II. Published by the Sanitary Institute.

whooping-cough, and some other maladies, such as those which were once common in hospitals, the virus is transmitted by intermediate substances, especially clothing, on which it has settled. The investigation of influenza especially has led to a very clear realization of the subtle manner in which the light microbic dust has been conveyed from place to place. Ample and unguarded channels of access by some of the millions of objects daily passing between nations and towns, and especially by the rapid continuous travelling of the present age, admit of a much more thorough and swift distribution and rekindling of permitted pests than has ever before taken place. Numerous gatherings of all sorts at which infectious persons are present, free intercourse between the sick and healthy, and the general neglect of ventilation, bring all but the most refractory subjects within the power of an unregulated epidemic.

The gist of Sanitary Science is thus comprised in the two principles—Cleanliness, Isolation. To these must be added, for the purposes of efficient administration of health in States, a third, namely, Unity of Administration. And health measures throughout the country require, beyond all question, the most highly-trained scientific officers, keenly alive to the nobility and power of their vocation.

The health officer of our time knows that the above principles must be interpreted in a wide and comprehensive sense. We have, for instance, the clear duty cast upon us of providing for the welfare of domestic animals as for ourselves, and if we do not fulfil this duty, mankind must inevitably continue to be a sharer in those bodily sufferings which our neglect has caused in them. More than one of the maladies which lead to great distress and sorrow among us are traceable to parsimonious and inhuman conduct towards the animals which depend on our care.

Revered leaders of high authority have shown that epidemic diseases, far from being due to mysterious "telluric and meteoric influences," as was often whispered fifty years ago and less, are really caused by vulnerable, destructible, preventable products of organic life, and that it is well within the power of nations and individuals to drive them from the face of the earth.

Deeply interesting and important researches have disclosed the nature of the agents concerned in many of these pestilential maladies; only indolence or pedantry, disguised in the awful garb of scientific reserve, would ask for a complete demonstration of the character of all before acting on the known principles of preventive science. In effect, the control of epidemics is now chiefly a matter of national instruction and practical government.

Their expulsion will bring not only physical but moral gain, for as all epidemics imply moral and mental deficiencies which have allowed them to spring up, so it is the common experience, that, on the whole, the greater the insecurity of life, the lower the moral condition of a people. The great plagues of history have been followed by times of lower moral as well as of lower physical vitality. And the principles which lead to the extinction of plagues will naturally be joined by a stronger sense of the community of the whole human race, and of the need, for the good of the whole, that valleys of darkness should be raised into light and paths of perversity be made straight, and hunger of body and mind, the hunger of famine, be appeased, in every part of the world.

APPENDIX I.

Influenza, etc.—Some circumstances in certain outbreaks of diseases resembling influenza, and of influenza itself, lead to the suspicion that the microbe concerned in a similar disease in sheep and other animals, may in certain circumstances be transferred to man, and that when the transference or inoculation has taken place, an accession of virulence is acquired, such as is known to happen in many instances when a virus is passed through animals of another kind than that in which the disease arose. One instance of this is the growth of intensity of the microbe of rabies in the dog, when transferred to rabbits. Another is the greatly increased virulence and infectivity of scarlet fever when transference takes place from the cow to man. Similarly, diphtheria in man seems to be capable of being transmitted through a slight ailment in the cow.

Influenza, or something very like it, arises, as we have seen, in the crowded sheep-shearing sheds of Australia, when the men are brought into close contact with the exhalations of sheep, some of which are probably affected with catarrhs or other disease. In Bokhara, it is noted in *Unsere Zeit,* by a writer who was there, that the people were crowded within the walls with sheep and other animals. Dr. Thornton, of Canterbury, reported (*Lancet,* March 29, 1890) that in that part of the country, as early as October 14, 1889, lambs began to suffer from a malady the like of which was certainly not known for more than twenty years. On three farms adjoining, the horses were attacked with influenza after the lambs, and lastly, the people of the farms. These may have been mere coincidences, and the disease from which the sheep suffered is not clearly stated.

In several recorded epidemics, horses and other animals have been previously or concurrently diseased. But data are insufficient to show whether man or animals have been the first to be affected. Wild animals, herds of deer, and rabbits, which last the Berlin investigators have found very susceptible to inoculation, are nowhere mentioned as having suffered.

If any hypothesis may result from these considerations, it might be this: That a mild disease of the influenza kind passes from man to animals, or originates in animals where crowded in bad conditions, and is then with difficulty transplanted to man, but when transplanted, acquires fresh virulence and intense infectivity to susceptible subjects. Its increase in virulence after having passed through millions of human beings seems to agree with the known development of very serious diseases from slight cases. The specific character of the influenza bacillus appears now to have been proved by the researches of Pfeiffer, Kitasato, Canon, and Koch.

The extreme ease with which influenza may be carried so as to affect susceptible subjects becomes quite intelligible when the extreme minuteness of the microbe is realized. Smaller than the bacillus of mouse septicaemia, the bacillus of influenza measures about $\frac{1}{50000}$ of an inch in length, and perhaps $\frac{1}{250000}$ of an inch in breadth.[1] Thus, on the surface say of the gum of an envelope fastened by a patient in the ordinary way, there might be one thousand million of these organisms, with plenty of room left unoccupied. The possible number which could be packed into each square inch largely exceeds the number of inhabitants of this planet. A cubic inch, if closely packed, would contain 3125 million millions, or more than 2,000,000 times the inhabitants of the earth.

Yellow Fever.—Yellow fever is always found more or less on the Guinea Coast of Africa, in Brazil, Mexico, and in the southern part of the United States.

Dr. Creighton[2] suggests that the slave-ships from Africa, crowded with negroes, and subject to hideous conditions of filth and disease, especially dysentery, may have led to the production of the yellow fever which attacked the whites and spared the negroes. "The ports of debarkation of the slave-trade became the epidemic seats of yellow fever. The theory is, that the matters productive of yellow fever were brought to the West Indian harbours, deposited there, left to ferment and accumulate, and so to taint the soil, the mud, and the water, and to become an enduring source of poisonous miasmata." "The ships' bilges would be foul beyond measure; and it was just the contents of the bilges that would be pumped or

[1] *Lancet,* Jan. 16, 1892. The size of the microbe is given as about half the length and the same breadth as the microbe of mouse septicaemia; that is, about $\frac{1}{50000}$ in. long and $\frac{1}{250000}$ in. broad.

[2] *History of Epidemics in Britain.* 1891.

thrown out when the ship was moored in the harbour or careened on the mud." "The careenage at the head of the bay was the regular receptacle of the ordure of slave-ships year after year. Yellow fever is a fever of only a few *inhabited* spots, and the steady seats of it are all harbours at some time distinguished as the resort of slave-ships. Everything points to its being a poison lurking in the mud or even in the water of the slave-ports, and in the soil of their fore-shores, wharves, and houses along the beach. The poison entered the bilges of ships moored in the harbour, and rose from the holds as a noxious vapour to infect the crews. The periodic epidemics of yellow fever are apt to occur when the ground is unusually dry, subsoil water low, and the pores of the ground filled with air to an unusual extent. Yellow fever may almost be described as a typhus of the soil. It has its habitat in the soil, like plague, and like cholera; and it depends largely on the state (level) of the ground water."

Tetanus.—Prof. G. Sormani has recently shown that the surface of the ground in streets, courts, squares, and gardens, and the sweepings of dwellings, contain swarms of the germs of the tetanus bacillus. These bacilli are found to infest the droppings of various domesticated animals, and may cause disease in them through the alimentary canal, or in mankind through an abrasion of the skin. On the other hand, Turco has found a positive result from horses' excrement, cattle, street-scrapings, plaster, etc., only once in thirty-nine times, but from matter collected in the neighbourhood of a case of tetanus, five out of nine times. Drying, light, and putrefaction did not kill the bacillus, which was virulent after thirteen months' exposure; 80° to 90° C. did not kill it.

Pneumonia.—Drs. G. and F. Klemperer have recently carried out investigations [1] on the microbe of pneumonia, the pneumococcus. They found that any culture medium which had served for the nutrition of the pneumococci, even after filtration, conferred immunity on an animal against infection. The blood-serum of an animal thus vaccinated against the pneumococcus was found capable of curing an animal infected with pneumonia. An intravenous injection of eight cubic centimetres of serum of an animal rendered refractory, twenty-four hours after infection, hastened recovery. The blood-serum of an animal made immune contains "anti-pneumotoxine." Six patients affected with pneumonia were treated with an hypodermic injection, which was followed by slowing of the pulse

[1] *Berliner Klinische Wochenschrift*, August 1891.

and respiration. On infected rabbits, full immunity was obtained by intravenous injections of a culture having its entire virulence, but largely diluted.

Typhoid Fever in India.—Dr. J. Lane Notter suggests that typhoid in India may be caused by the *spores* of the bacilli living in the soil, and after a fall of soil-water and consequent access of air to the interstices, the bacilli or spores may be carried into the atmosphere with the upper soil layer either as dust or with ascending air-currents, so as to affect neighbouring dwellings. Typhoid is most prevalent in April, May, and June, when the upper soil is driest, and at a temperature of 72° F.

Seasonal Prevalence of Infectious Diseases in England.—The month in which the following diseases begin to be most prevalent is, for—

Small-pox	January.
Measles	December.
Scarlet fever	August.
Diphtheria	September.
Whooping-cough	December.
Typhus	October or December.
Typhoid	August.
Erysipelas	October.
Diarrhœa and cholera ...	July.

The maximum prevalence of small-pox is in May, of measles in December, of scarlet fever in October, of erysipelas and diphtheria in November.

The great tendency towards a rise in frequency of many of these diseases in the winter months, or as the weather becomes cold, seems to indicate in their cases a preponderance of the effect of crowding, absence of ventilation, and infection by proximity, over any effect of primary development. In scarlet fever, diphtheria, typhoid, cholera, and diarrhœa, however, a certain high temperature seems to favour the development of the disease so much as to counterbalance the effect of direct infection due to crowding and bad ventilation.

Cholera, diarrhœa, typhoid, and diphtheria are known to be capable of growth on material, such as decaying organic matter, outside the body, and these appear to be favoured by high temperature and to be given off in quantities, after hot weather, sufficient to cause a distinct rise in the prevalence of the disease. In the cases of diphtheria and typhoid, however, personal infection, direct and indirect, is so large a factor, that the rate of prevalence becomes very high during the early part of winter, when bad ventilation and indoor life tell most effectually. The occurrence of a maximum of scarlet fever in October seems to point to a frequent origin or spread from exterior sources, such, possibly, as farmyard refuse under a high temperature. The period of incubation of scarlet fever is short, and therefore the maximum prevalence would occur not very long after the cause operating to bring it into unusual activity and development.

Small-pox, which arises entirely from previous cases, and has a long period of incubation, has the maximum in May, when the effects of winter overcrowding would have led to a wide distribution of the infection.

All the common highly infectious diseases in England except measles have a high rate of prevalence in January.

The great importance of ventilation is indicated by these facts.

Ventilation.—While the removal of noxious animal and vegetable matter in the liquid and solid form receives much attention in these days, we are still, to a great extent, subject to conditions of air which, if they could be made palpable to the eye, would be recognized as poisonous and disgusting. Air drainage for rooms, halls, churches, schools, and shops (especially where provisions are sold), is quite as necessary for salubrity as the proper disposal of sewage. To breathe over again air which has been largely breathed before, is to expose the system to gaseous and particulate organic products which are often noxious and always unwholesome. Yet in all assemblies and crowded rooms a very foul air is the ordinary experience. Many infectious diseases pass easily from person to person through such air, when they could not do so through fresh air with its normal oxygen and ozone. Association in bad air is in fact the principal means in the extension of most of the worst infections. And when no positive malady is the result of living in ill-ventilated rooms and crowded places, the decline of robustness is plainly visible in people accustomed to bad air. They can no more thrive for several generations than trout can thrive in a stagnant pond. Some simple machinery or method is urgently required for bringing fresh warmed air continuously into dwellings and public buildings.

Maritime and Inland Sanitation.—In an address by Dr. Montizambert, Superintendent of the Canadian Quarantine Service, he lays stress on the importance of a thorough system of marine sanitation at the ports of entry, and of prevention and preparedness in the interior communities. The interior communities throughout the length and breadth of the Continent have a very close and vital interest in the fittings and working of the Quarantine Service at the various ports. But confidence in a quarantine system, however perfected, must never be allowed to lull us into a false sense of security, to the neglect of sanitary improvement in towns, villages, and districts throughout the country.

Consumption, Tuberculosis.—In 1890, an order was promulgated in Berlin, making tuberculosis one of the infectious diseases of which notice was to be given, and in which disinfection was to be practised.

In America, attention has been called to the danger of sleeping-cars on railways, which seem adapted to the propagation of this disease.

The following memorial, which seems to mark an epoch in the campaign against tuberculous disease, has very recently been made public—

The following memorial has been sent to us for publication—

"To the Honourable the Lord Provost, the Magistrates and Council of the City and Royal Burgh of Glasgow, as the Police Commissioners thereof.

"The Medico-Chirurgical Society of Glasgow, a body consisting of over 200 members, mostly practitioners in the West of Scotland, held a discussion, and arrived at the following resolution at a meeting on the 18th of December, 1891—

"'That a memorial be presented to the Town Council of Glasgow calling their attention to the fact that tuberculosis is now fully recognized as an infectious disease, and asking them to take the matter into their serious consideration, with a view to the protection of the community from the infection.'

"A committee was afterwards appointed to frame such a memorial as would serve to indicate with somewhat more of detail the views and objects aimed at in the resolution. We beg, accordingly, to submit to your Lordship, and to the magistrates and the Town Council, the following considerations—

"1. Tuberculosis is an infectious disease in the sense that in all cases of this disease the one constant and necessary element in the causation is a microbe. This microbe grows and multiplies in the bodies of certain animals and of man, when introduced from without, and in so doing it produces an intensely active poison which is the more direct agent in bringing about the morbid changes in the living structures. There are doubtless other elements in the causation, such as inherited and acquired susceptibility, but the microbe is the only essential and constant one, and there is evidence to show that, without any special susceptibility, it may produce the disease if introduced in sufficient quantity.

"2. As the microbe will not grow except at a temperature almost identical with that of the body, the living bodies of men and animals affected are the great propagating places of it. They are the sources of the supply, and constitute the centres from which the infection is derived. But the microbe is not retained in the bodies of the persons affected. Most of the forms of tuberculosis are characterized by discharges of matter from the affected parts of the body, and these discharges contain the microbe—often in very large quantities. The most frequent form of tuberculosis is consumption of the lungs, and persons affected with this disease almost constantly spit up matter which is loaded with the infective microbe. The spit of such persons when dry is liable to be pulverized into fine dust, and this in its dissemination carries the still living microbe with it.

"3. It is believed that tuberculosis is fairly to be compared, as regards its infectious quality, if not with typhus and small-pox, at least with typhoid or enteric fever, although the mode and channel of the infection may be so different as to make it much less obviously dangerous to live in the same house or room with a case of consumption than it would be in the case of one of the well-known contagious fevers. Tuberculosis, however, is much more disastrous in its results than all the other infectious diseases put together. According to the annual report of the Registrar-General for 1888, the deaths registered as due to tuberculosis in Glasgow numbered 1824, and those assigned to all other miasmatic—that is, infectious—diseases, including measles, scarlet fever, whooping-cough, &c., were 1089. For reasons known to us, it seems certain that the mortality from tuberculosis considerably exceeds that which appears in the Registrar-General's returns, but even these figures are sufficiently striking. The deaths registered as tuberculous made up 15·5 per cent. of the total deaths in Glasgow in 1888. These facts imply a large amount of what may be called 'floating infection' in our midst.

"4. The Town Council by its action in prohibiting the sale of tuberculous meat and milk has, in our opinion very properly, endeavoured to grapple with one source of the infection. It may be said that the great prevalence of tuberculosis in cattle, especially in milk-cows kept in town-byres, and therefore both more likely to be infected with tuberculosis and to become, in turn, sources of infection through their milk, has justly been already considered by the authorities. We recognize the wisdom of a policy having for its object the removal of this source of infection, which is dangerous for man as well as for animals. It should be possible by rigid cleansing and disinfecting of byres, and by the condemnation of all carcasses of animals known to be tuberculous, to stop this source of infection.

"5. It is not for us to prescribe the mode in which the infection should be dealt with in the case of man. The Council has skilled officials whom it can consult on the matter. But we venture to suggest that a beginning should be made with a definite attempt to stay the infection. If the public were authoritatively informed of the harmful nature of all discharges from tuberculous persons, and more particularly from cases of consumption of the lungs, and if they were encouraged to have these discharges rendered innocuous, and also to submit their houses and clothing to disinfection at intervals during the currency of the disease, and again at its close, it is believed that much good would result. With the splendid sanitary organization which Glasgow possesses, it should be possible to do much to cleanse our city from some of the principal causes of the wide-spread prevalence of this its greatest plague.

"On behalf of the Society,
"Joseph Coats, M.D., President.
"W. T. Gairdner, M.D.
"Hugh Thompson, M.D.
"John Lindsay Steven, M.D.
"Chas. Workman, M.D.
"J. Walker Downie, M.D., Secretary."

APPENDIX II.

A NATIONAL HEALTH SERVICE.

MUCH substantial work has been quietly accomplished in recent years upon the edifice of sanitary law, especially in extending local facilities for dealing with unwholesome areas in towns. But there is at present in England no fully-equipped national organization or system for dealing radically, promptly, and efficiently with human pestilential disorders, no uniform national machinery for guarding the shores of this country from invasion by every kind of dangerous infection, and no general adaptation of the practical methods indicated by recent science for the extermination of fatal and impoverishing scourges, which are ever ready to break out in a large population in multitudinous commercial connection with every other nation, and internally pervaded by intercourse unexampled in quantity and rapidity. The very extent of the perpetual communications of a civilized country may seem to render the task of exclusion of the more swift and less shunned pestilences almost hopeless, but, on the other hand, there is very much in the history of sanitary effort which tends to encouragement, showing the sensitiveness of this class of disease to vigorous persecution. A mass of evidence exists to show that epidemics do not usually break out on a great scale unless precautions have been greatly neglected, or deemed unnecessary, and more than one path left open and unguarded. Just as a heap of half-dry brushwood often fails to burn up if ignited at one point, but, if lighted at many points, will almost certainly catch fire, so a few points of access are often insufficient to start an epidemic, but many cases give so many more opportunities that some are certain to result in combustion of material fitly laid, and so the conflagration becomes general and beyond control. That the matter of infection cannot be wholly and absolutely excluded is therefore no reason against making its abundance impossible. No disease of the spreading class is able successfully to cope with the means at command of a population determined to arrest it. Hospitals are seldom, if ever, free from the germs of infectious diseases of various kinds, but by excellent management, ventilation, and cleansing, these are reduced in quantity and intensity below the degree of harmful operation.[1] Institutions and health-resorts to an unusual degree liable to the importation of infection are yet able by a sharp look-out, notification, and instant isolation, to keep their people unusually exempt. Just as mould, just as vermin, may be so widely-spread and copious in a dwelling-house that it might be thought hopeless to make of that house a wholesome and pleasant habitation, and yet by light, air, and frequent disturbance a riddance is effected, so the less visible blights that flourish in bad conditions of air, water, or soil are routed and put to flight by the disciplined administration of the cleansing and renovating elements of nature. Enough is known in the present day to make the application of these forces systematic, regular, precise, and effectual.

If it were proposed to dissolve the present organization of the British Army, and to reform it under a new scheme by which, instead of the service being planned on a national basis with a gradation of officers all under the command of central authorities representing the State, the country were to be divided into numerous districts, and captains, colonels, and generals were to be elected by the ratepayers of their respective towns, union districts, and parishes, and were to be independent of each other, and practically independent of State control except on special occasions, and were to be provided by their electors with all sorts of different weapons, including battleaxes and blunderbusses, and were to receive rates of salary varying from about one-seventh of the wages of a farm-labourer to twenty times that amount, and if there were a prospect of raids by foreign enemies becoming so frequent as to cause daily ravage in some part of the country, few would be found to approve of so dangerous an innovation.

Yet such an incoherent jumble is almost exactly presented by our existing sanitary constitution.

If, instead of our excellent Fire Brigade system, by which the outbreak of a fire in London becomes quickly known both to the local fire brigade and to the Central Establishment, small districts

[1] In the report of the London Fever Hospital for the past year it is stated that in no instance did an infective disease of any kind spread to a case in hospital of another kind—a triumph of management.

or parishes were to be left to manage as they chose, and were each to work or not to work a little system of their own, we should soon have a great increase of serious fires, the destruction of property would be enormous, and many extensive conflagrations would cast a lurid glare upon incompetence and disunion.

All distinguished sanitarians who have inquired into these matters have condemned in the clearest and strongest manner the working of the present permissive code among a chaos of local bodies. I may here refer especially to Mr. Ernest Hart's very instructive paper in the *Transactions of the Sanitary Institute* for 1885-6, and to the lecture given to the Congress in 1889 by Sir Douglas Galton, who used these words: "The Medical Officer of Health ought to give his whole time to his duties"; and, "Is it not a matter of astonishment that so little care is taken to obtain skilled officers to perform the duties of supervision, and especially that so little consideration is given to the importance of remunerating them adequately for the knowledge which they have been obliged to acquire to fit them for the laborious duties which they have to perform?" Again he says, "The Sanitary Inspector must have a certain amount of scientific knowledge, combined with much practical experience, if he is to exercise his duties effectively."

It seems scarcely credible, but it is a fact, that many medical officers are appointed by their unenterprising districts at salaries of £20, £15, £10, and even £5 a year, and, what is worse, are often reproved if they make their office, which ought to be a distinguished and beneficent one, anything but a sinecure. If an efficient medical officer saves by his action only fifty cases of illness per annum, his constituency is the richer by at least £150 directly, and indirectly by probably a larger sum, owing to the prevention of lifelong crippling of wage-earners after malignant fevers. It is an astounding truth, of which many a revolting instance might be quoted, that the Sanitary Authority is sometimes the most obstinate enemy of life-saving and of public welfare in their district. Can we imagine a fire brigade which refused to turn out, or even to raise their eyes, on being called to extinguish a fire? Can we imagine the officers of a regiment called upon to repel the enemy just landing on the coast, declaring that they had themselves never been wounded, had never seen foreign troops, and would not believe in any dangerous foe till they were roused by bullets in their houses?

The present jumble of sanitary authorities, and the machinery of public health service as at present existing, is inadequate to attain the purpose for which it was created. In the same volume of the *Transactions of the Sanitary Institute* as that which contains Mr. Hart's paper on Local Government Reform, and as an Appendix to that paper, is a remarkable document, written so long ago as 1877, which may still be regarded as a kind of Sanitary Charter. It is a Memorial of the Joint Committee on State Medicine of the British Medical and Social Science Associations, and was addressed to the Earl of Beaconsfield.

In paragraph [2] the Memorial alluded to runs as follows—

"Your memorialists have been very strongly impressed with the need of economy in carrying out sanitary improvements, and generally in the administration of the functions of local government, and they believe that a reconstruction of sanitary agency, such as hereinafter recommended, is consistent not only with complete efficiency, but with the accomplishment of a much larger amount of work done at a less cost than at present. This can readily be obtained by constituting, instead of the many local authorities under various names now existing, one elected and representative body, clothed with all executive functions whether municipal or sanitary, within the area of its jurisdiction."

Then, in the fourth paragraph, they make, among others, the following admirable suggestions:—The Health Officers of the County Boards to be men of high scientific attainments and acknowledged ability, paid adequate salaries for superintending the whole or a division of a county; to these county officers should be added medical officers of a district with assistants, all forming part of a great Department of the State, under the presidency of a Minister of Health; but all these officers should be under central control, so far as making up one great body of workers for general State medical purposes. In this as in all other departments of local action there should be the minimum of interference with local government. All officers of health should be debarred from private practice, and be holders of diplomas in State Medicine, a portion of their salaries paid out of money voted by Parliament, the rest out of local rates.

It is no exaggeration to say that as tens of thousands of lives have been preserved, and hundreds of thousands of cases of illness have been prevented, especially in large towns, by the Sanitary Acts at present in force, so a State system like that proposed would reduce the most destructive fevers in a few years to very small proportions. Every part of the kingdom should be in sympathetic communication with the Central Board, and the President of this Central Council should be a Moltke of the medical profession. As things now are, a single filthy village or neglected suburb may develop scarlet fever, or typhoid, or diphtheria, and in the course of a few weeks or months neighbouring farms or watercourses or lines of railway assist in spreading the infection far and wide, till the original seat of the mischief is unsuspected. A Local Government Board inquiry, with results of signal benefit for the future, may, in a few instances, take place, but long after the inception of the outbreak, and much too late to kill the epidemic in its early growth, when it might be easily extinguished.

The backwardness of many country places and districts over a large part of England is scarcely credible to those who know what great results have been achieved in others, even under present powers and with the present disjointed machinery. Responsibility is too much diffused, too little realized, and appointments are too much a matter of routine. The name and address of the medical officer and of the inspector are known to few, and their visits are rare. They may live at a great and inconvenient distance from parts of their area. The medical officer is engaged in private practice, and in the outbreak of an epidemic he confesses himself "too busy with patients" to endeavour to stop it. There are many duties connected with the post of medical officer which are obviously most improperly combined with a continuance of general practice. He has to visit places in the worst condition and to visit susceptible patients. The inspector is in too many places unqualified, wholly unscientific, and perfunctory, and yet the issues of life and death, competence and indigence, are largely dependent on his action. Complaints are often for a long time unattended to. The complaint-book is not put prominently before the ratepayers, and an open register of the condition of houses is not in use. Systematic inspection, as enjoined by law, is neglected. No store of powerful disinfectants, no simple disinfecting apparatus, is kept in every village, ready for emergencies. There is little or no communication between the authorities, medical officers, and school-managers of adjoining districts. Virulent disease may have existed some time in a village without notice being given to neighbouring places. If the matter were swine fever or cattle disease, public warning would be given. Isolation hospitals and ambulances are rare.

Incomparably superior the method employed where the scope and power of the Central Authority are wider. The Board of

Agriculture has power for the prevention of disease in cattle, and has recently used it to the best purpose.

On Feb. 4, 1892, the inspector at the Metropolitan Cattle Market discovered that six animals out of a herd of eleven Danish cattle were suffering from foot and mouth disease. The observation being confirmed by the veterinary inspectors of the Board, the gates of the market were at once closed against the exit of animals. It was found that the animals formed part of a cargo of sixty-eight, which sailed from Denmark on Jan. 27, was landed at Harwich on Jan. 30, and after examination at the port, entered the cattle market on Feb. 1. All beasts then in the market were slaughtered. Telegrams were sent to all the local authorities enjoining precautions. The inspectors were ordered to detain all Danish cattle. Further importation from Denmark was prohibited. The fifty-nine animals which formed part of the cargo were all traced before the close of the day to their destinations at Chatham, Rochester, Aldershot, Shorncliffe, Stratford, and in the metropolitan district, where the bulk of them had remained. These were slaughtered. Animals which were found to have been in contact with them were also slaughtered. All movement of animals in the metropolitan district and in the places where the cattle were found was prohibited. Several outbreaks occurred in and beyond the district in animals which had been in the market; these were slaughtered, and the places disinfected. Inspectors were appointed to visit and watch the metropolitan dairies, and instructions issued to all the local authorities in the district. The holding of markets was temporarily prohibited. The foreign consuls are habitually instructed to send information of the outbreak of cattle disease, and to keep careful watch. It seems probable that in this case the disease was not introduced from the suspected country, but none the less were these measures the best that could be devised in the emergency, and likely soon to reveal the true source of infection.

With regard to pleuro-pneumonia in cattle, this plague has been greatly reduced since the control was transferred from the local to the Central Authorities. The old plan of local administration, and of putting a cordon round small infected areas, had been a disastrous failure, but with Central Control and the scheduling of large areas declared infected, a great diminution of the disease, and consequently a great saving of expense, became apparent.

So with regard to human diseases, *mutatis mutandis*, such a system in the nature of things is the most reasonable. The foresight, the science, the skill, the promptness, the foreign communications of a Central Authority in cordial co-operation with local bodies are indispensable in order to attain the highest success. There would be much advantage in the distribution through the Post Offices of general instructions and precautionary guides against spreading diseases and for the promotion of public health, in order that measures of extinction might receive intelligent support. By the co-operation of the people on whom these calamities fall so heavily, the incidence of infectious maladies over Great Britain might become daily known at the Ministry of Health, where they would be charted and tracked, their extensions marked and checked, and their causes and means of sustenance removed. By quick, continuous, organized control they are capable of suppression. Then the burden of poverty will be lightened, the national vigour increased, and many a home which had otherwise been dark and bitter will be preserved in "quietness and assurance."

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(*Quoted from or referred to.*)

THE END.

LONDON: EDWARD STANFORD, 26 & 27 COCKSPUR STREET, CHARING CROSS, S.W.