may, therefore, describe two forms of right duodenal hernia, the former as hernia mesenterico-parietalis parajejunalis, and the latter as hernia mesenterico-parietalis paraduodenalis. In both varieties the anterior margin of the sac contains the

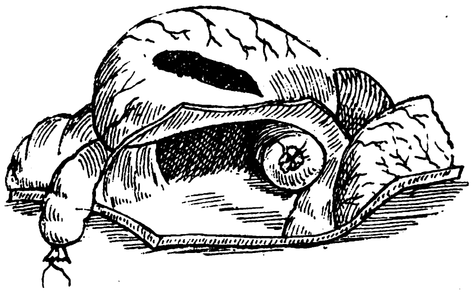


Fig. 10.—Orifice of the sac of a right duodenal hernia.

superior mesenteric artery. It is interesting to note that in two recorded cases, Zwaardemaker's and Neumann's, there was a twisting of the bowel at the orifice of the sac, amounting, it is said, to volvulus.

DIAGNOSIS.

Duodenal hernia, unless strangulated, gives rise to practically no symptoms. In many cases the hernia has been found accidentally on *post-mortem* examination. When strangulation occurs, in addition to the symptoms of acute intestinal obstruction a characteristic appearance of the abdomen has been noted. (Fig. 11.) There is a tumour in the central part of

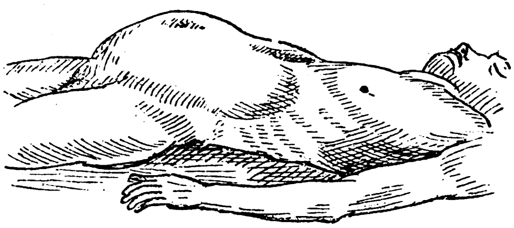


Fig. 11.—Aspect of abdomen of Dr. Barrs's case of right duodenal hernia.

the abdomen and around it a flattened area. The tumour has the following attributes.

1. It is limited to a definite region of the abdomen. In left duodenal hernia it lies at first to the left and upper, in right duodenal to the left and lower parts of the abdomen, but in each case spreads eventually over almost the whole abdominal cavity. Around the tumour is an area of depression corresponding to the position of the colon. In size the tumour may vary. It has been described as being of the size "of a child's head." In Dr. Barrs's case it was "equal to a nine months pregnancy." It is slightly movable, but fixed during respiration.

2. The tumour is marked out distinctly by palpation. On percussion it is always resonant. The degree of resonance varies in different cases, and in different parts of the same tumour. But the striking feature is that the tumour is a palpable, definite, resonant mass. In the centre of the tumour or over its whole mass may be seen coils of intestine. The tumour may bear a very obvious relation to the clinical condition of the patient, becoming more tense and prominent and very much more tender when the symptoms undergo exacerbation. As the symptoms decline the tumour becomes less aggressive.

3. On auscultation distinct gurgling sounds may be heard anywhere in the tumour.

It is important to remember that, owing to the position of the inferior mesenteric vein in the neck of a left duodenal sac the radicles of this vein may become enlarged, as in the case of the hæmorrhoidal veins; or venous trunks on the anterior abdominal wall may be so increased in size as to form a striking feature of the case.

THE medical practitioners of Yukon have, it is announced, organised a Yukon College of Physicians and Surgeons to examine all practitioners seeking to settle at Klondyke.

# THE MILROY LECTURES
ON THE
# EARTH IN RELATION TO THE PRESERVATION AND DESTRUCTION OF CONTAGIA.

*Delivered at the Royal College of Physicians of London*

BY G. V. POORE, M.D., F.R.C.P.LOND.,
Professor of Medical Jurisprudence and Clinical Medicine, University College; Physician to University College Hospital.

LECTURE II.[1]
ENTERIC FEVER.

MR. PRESIDENT AND GENTLEMEN,—Enteric fever has of late years much occupied the attention of epidemiologists and bacteriologists, and our knowledge of its definite relationship to filth, milk, and water has undergone considerable increase. The laboratory experiments connected with enteric fever are of great interest and value, but it would be, to say the least, hazardous to build upon them any measures intended for practical sanitation. It must never be forgotten that the typhoid bacillus does not fulfil one of Koch's postulates. The disease produced by the inoculation of guinea-pigs with pure cultivation of typhoid bacillus has but a remote resemblance to the disease which we clinically know as enteric fever, a disease which seems limited to the human species. Sidney Martin[2] finds that hitherto "none of the ordinary cultures of the typhoid bacillus obtainable in the laboratories will kill an animal, but that it may be rendered virulent by inoculation and transference through a succession of peritoneal cavities, and also by injecting simultaneously the products of other micro-organisms, such as streptococcus or bacillus coli communis. It is noteworthy that the bacillus coli communis and Gaertner's bacillus, when subjected to similar manipulations, are as toxic to rabbits as is the typhoid bacillus. It must be remembered that "pure cultivations" of the bacillus typhosus cannot be said to exist in Nature. We recognise, and it may be taken as proven, that the main cause of the endemicity and epidemicity of enterica in this country is to be found in the fæces of the patient, and yet Martin tells us that while the bacillus is invariably found in the spleen and mesenteric glands and in intestinal lesions, "it is found in some cases in the motions of typhoid fever and also in the urine."

Dr. Carver, working under Delépine at Manchester, found the typhoid bacillus twice in twenty samples of typhoid fæces and once in sixteen samples of typhoid urine.[3] Martin, working with sterilised soils, has shown that in soils which are more or less "polluted" with organic matter, the bacillus typhosus will continue to live and spread at ordinary temperatures, but that in virgin soils the pure cultivations of the bacillus die out from some unexplained cause. Martin gives one experiment[4] to show that in unsterilised soil containing much organic matter the bacillus may continue to live, but as yet there has been no evidence of spreading.* Robertson and Maitland Gibson[5] collected thirty samples of soil from areas which they considered likely to be infected. "In not one single instance was bacillus typhosus found."

Laboratory experiments tend to show that vegetation (grass) prevents the growth of the organism, which may explain "why typhoid fever is so much more prevalent in towns than in rural districts." Attempts to prove the aërial conveyance of the organism from liquid filth have failed.

Let us now turn from these experiments to the practical experiences of sanitarians. It may be premised that Martin's experiments show that the bacillus typhosus will grow in any soil rich in organic matter, and that, although aërobic, it can be cultivated as an anaërobe, even in an atmosphere of carbonic acid,[6] and that it is destroyed by sandy or peaty "virgin" soils. Robertson and Gibson cultivated the bacillus on a soil in which clay predominated. Sir Charles Cameron is of opinion that it flourishes in gravel.

Dr. Scurfield of Sunderland has said that "the greater part of the county of Durham in which typhoid fever had been prevalent during the last few years was covered with stiff boulder clay, and in the urban district of Sunderland typhoid

* The persistence of the bacillus typhosus appears to depend on feeding it with fluid nourishment. A sewer leaking into the soil would do this or liquid filth in a privy.

fever had been just as prevalent in the boulder clay as in the houses built on sand or gravel." Pettenkofer is mainly answerable for the theory that enteric fever is due to a soil organism which grows with maximum vigour when the level of the ground water falls.

The subsoil water in Munich is derived from the mountains, and when these are covered with snow the subsoil water falls. It is a most interesting fact that Pettenkofer's Munich typhoid fever was a disease of winter.

The average English sanitarian, reading an account of Munich with its soak-away cesspools and foul drinking water, would not need any new theories to account for the prevalence of typhoid fever. If we accept Pettenkofer's theory that the fever was due to organisms in the subsoil, it is interesting to observe that the Munich fever, unlike typhoid fever in other places, reached its maximum in February, and was most rife in the coldest weather, when the surface of the ground must have been often frozen. During the winter months, when the big houses were closed and the stoves were lighted, the interior of the houses must have been filled with cesspool air. An organism permeating the soil might be expected to die out gradually. The sudden fall of the death-rate from 72 in 1880 to 18 in 1881 seems to imply that the organisms suddenly died over the whole area of the city. Munich is a city in which the general sanitary condition has undergone gradual amelioration. Sewers on modern lines were begun in 1878, and 800 private slaughterhouses were destroyed in the same year. There is now a highland water supply, and typhoid fever has gone. But it is needless to say that the subsoil water rises and falls precisely as it did half a century ago. The connection of typhoid fever in Munich with organisms growing in the soil is to my mind not proven.

Enteric fever has long been regarded as a filth disease, and there is abundant evidence that filthy surroundings, such as water-logged privies, soil sodden with the leakage of sewers, the air of cesspools and traps, proximity of waterclosets to the kitchen, in some way or another predispose to it. While we agree as to the fact we may differ as to the explanation. Some would assert that the bacillus typhosus is actually growing and spreading in the filth, and, indeed, that is possible, but direct evidence of it is wanting. Some would even say that the soil being inoculated the specific organism may continue to grow and spread in it far away from the point of inoculation, and so (by growth, not irruption) may poison the local water at a distance. Of this there is positively no evidence whatever. If for the sake of argument we allow that the bacillus typhosus may grow in the soil we have to ask how it emerges from the soil to do us harm? We are here confronted with contradictions. Robertson and Gibson showed that the bacillus disappeared in the winter to reappear in the summer, while at Munich the increase of enteric was a phenomenon of mid-winter. In Buda-Pesth it is associated with a rising ground-water, and at Munich with the opposite condition. In this country it is a disease of autumn and the period of floods, while others assert that it may be conveyed by dust, which ought to produce a prevalence in March. The opinions held by sanitarians and bacteriologists on this question differ widely, but there will be a consensus of opinion that a water-logged soil rich in organic matter is the one in which the bacillus typhosus is most likely to flourish. If this should be true the official position that in sewage treatment filtration through earth is a *sine quâ non* becomes untenable.

Loesener, in a paper[7] on the Viability of Pathogenic Bacteria in Interred Corpses, states that he injected into the vessels and cavities of dead pigs a great quantity of pathogenic bacteria, so that their number should exceed that of the saprophytes. In the first experiments the animals were not interred, and under these conditions the viability of the bacilli of typhoid fever and cholera did not exceed four or five days. When the animals were buried in a porous soil the pathogenic bacteria manifested a maximum viability as follows: Typhoid fever, 96 days, cholera 28 days, tubercle 95 days, bacillus pyocyaneus 33 days, pneumobacillus of Friedlaender 28 days, micrococcus tetragenus 28 days, and tetanus 361 days. The bacillus anthracis preserved its complete virulence during the whole year of the experiment, and the bacillus of *rouget du porc* and septicæmia of mice 234 days. As for the typhoid bacillus, it was possible to isolate it from the buried corpses only once. In only two cases was there evidence of any escape of the disease germs from the body.

Loesener's conclusion is that cemeteries are not harmful, provided the graves be surrounded by a layer of earth sufficient to filter the liquids traversing them.[8]

In the fifty-ninth annual report of the Registrar-General (1896) attention is directed to the special prevalence of enteric fever in a group of districts comprising nearly the whole of the county of Durham, together with the adjacent parts of Northumberland and Yorkshire. In the six years 1890-95 the mortality from enteric fever in these districts averaged 343 per 1,000,000 persons living, as against 173 for the whole of England and Wales. This seems to point to the fact that enteric fever is a disease of overcrowded industrial centres.

The epidemic of enteric fever in Maidstone in 1897 is of great importance in relation to the influence of the earth on contagion, and the report to the Local Government Board by Mr. Davy, Dr. T. Thomson, and Mr. Willcocks has put us in possession of most of the essential facts.

It was conclusively shown that the outbreak was due to the pollution of a spring or springs belong to the Farleigh water system. Of persons drinking this water nearly 8 per cent. were attacked, while of those drinking water belonging to other systems of supply less than 1 per cent. were attacked. The Farleigh springs, which are 15 or 16 in number, crop out on both banks of the Medway (mainly on the left bank) where the overlying and permeable green sand (locally known as "ragstone") rests upon the impermeable clay beneath. The water of these springs is for the most part pumped to the Barming reservoir, whence it is distributed mainly to the higher parts of the town. The Farleigh springs yield over 3,000,000 gallons a week, and their waters were all mixed in one reservoir, holding 500,000 gallons, before distribution. That this reservoir and the pipes connected with it became polluted with enteric poison was beyond doubt, but it was not quite so clear which of the contributing springs was at fault. When, however, the springs were examined on September 19th (between a fortnight and three weeks after the pollution which caused the outbreak had commenced) one, and one only, was found to be dirty—namely, the spring known as "Tutsham-in-Field." In order to condemn this spring, which yielded only 35,000 gallons per week, both chemical and bacteriological analyses were wholly superfluous, and accordingly it was cut off from the supply on the following morning, September 20th. This spring was reported as still dirty a month later, and when I saw it on November 5th it was still turbid and manifestly unfit for drinking purposes. Not only did chemical analysis indicate pollution, but great variability of composition even on the same day. It is noteworthy and of very great importance that diligent search was made for the bacillus typhosus by six eminent bacteriologists engaged but without success.

The lecturer at this point explained the differences in the physical conformation of the springs of the Farleigh group. That of Tutsham-in-Field, which alone showed evidence of animal contamination, is supplied by the under drainage of a hop garden. Its natural flow, as Fig. 1 shows, is aided by some 20 feet of earthenware pipes with open joints, lying on the clay 2 feet from the surface near the catchpit and 4 feet at the distant end. Above the channel where it is 2 feet below the surface is a fence made of stakes driven into the ground which must undoubtedly have acted as conductors

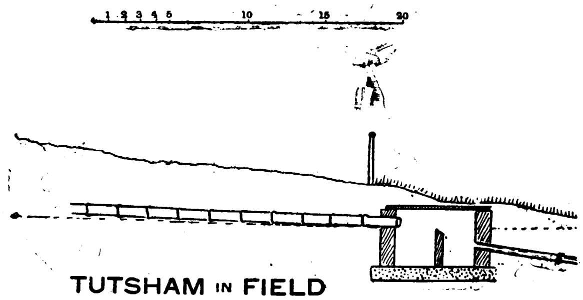



Fig. 1.

directly down to the water pipe. Near the fence were deposits of fæces. The line of the water pipe where it is near the catchpit corresponds very closely with the bed of the

TUTSHAM IN FIELD

Fig. 2.

natural surface drainage, and this spot is only a few yards from a path leading to a stile on the fence (see Fig. 2). In the case of two springs yielding good water, Tutsham-in-Orchard (Fig. 3) and Ewell (Fig. 4), the water pipes, open-

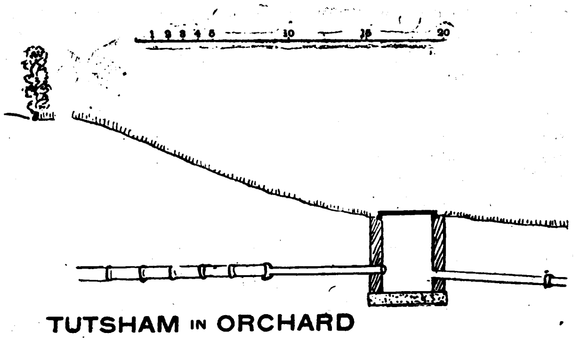
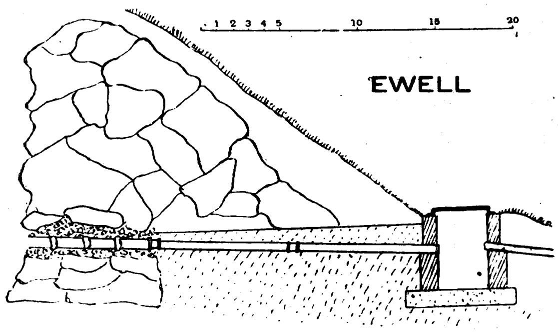



Fig. 3.




Fi 4.

jointed indeed as in the former case, are at no point nearer the surface than 5 feet and feet, respectively, and the surface consists in each case of turf.

The other epidemiological facts of this outbreak were shown by the lecturer to be quite compatible with the theory that the dirty water supplied from Tutsham-in-Field was the main cause of the outbreak. He then continued as follows: The inspectors in their report fix October 18th as the day when the influence of the Farleigh water ceased to be felt in Maidstone, and they say (p. 32): "Nearly all the cases notified after October 18th (some 280 in number) are to be regarded as having had a cause other than the consumption of Farleigh water." This opinion seems to imply that in the estimation of the inspectors the disinfection of the Farleigh water system, which began on October 16th and continued until November 4th was superfluous and useless. Speaking of the 280 cases, they say: "By Mr. M. A. Adams they were referred to direct infection from previous cases, and to insanitary conditions of waterclosets, drains, and sewers. This explanation appears to us to be the probable one if the insanitary conditions referred to be taken in the wide sense of including the fouling of the soil by leakage from these defective drains and sewers. Recent researches into the life-history of the bacillus of typhoid fever go to show that this organism finds in a soil contaminated with foul matters from leaky sewers, drains, and cesspools—conditions especially favourable to its vitality and multiplication. That the soil on which Maidstone stands is thus contaminated was set beyond doubt by the evidence put before us. To the existence of these conditions is mainly, we consider, to be attributed the remarkable persistence of fever in Maidstone after the primary cause of the outbreak had been removed by cutting off the Farleigh water supply."

Do the facts of the case really establish the conclusion which the inspectors say is "set beyond doubt?" I do not find a single word in the report or a single experiment to prove that the bacillus typhosus was growing in the soil of Maidstone. The epidemic is remarkable, not only for its severity, but from the fact that six gentlemen, all eminent for their skill in bacteriology, failed to discover a single typhoid bacillus. It may be, as the inspectors hint, was the case, that the bacillus typhosus was permeating the soil of Maidstone in November, December, and January, very much as a blue mould permeates a cheese, but no examination of the soil is recorded in the report. There are facts, however, which make strongly against any such contention. These were the total escape of the barracks and prison.

The report states: "The barracks and the Maidstone prison are both within the borough and both are connected with the town sewers." "The water supplied to the barracks is that of the Boarley system of the water company's supply." "At the prison the water used on week days is from a well 34 feet deep sunk in the Hythe beds of the lower greensand." During the five months—August to December—there were probably 800 persons who drank water from the 34-feet well sunk in the "contaminated" soil of Maidstone. Reference to the map (Fig. 5) will show that the prison is

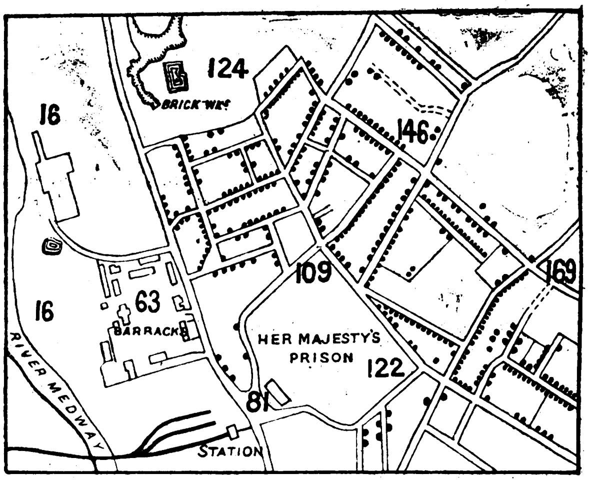



Fig. 5.

closely hemmed in on the north and east by fever stricken houses, yet neither rise nor fall of subsoil water brought typhoid fever or diarrhœa to the prison.

The investigations connected with the Maidstone epidemic are of great interest as pointing to the wonderful protection which the humus affords to the underlying water against pollution from above. The whole of the Farleigh springs were of the same character, the catch-pits of many of them were liable to leakage in time of flood, and the gathering ground of most of them was highly cultivated and manured land. And yet none of them—always excepting Tutsham-in-Field—afforded evidence of serious bacterial impurities. It may be added that in the third quarter of 1898 there was one death from enteric fever in Maidstone and another death from the same cause in the fourth quarter, so that the "contaminated" soil of Maidstone was not able to contaminate the inhabitants during the drought of July, August, and September or the rains of October, November, and December of last year.

### IMMUNITY.

Bacteriologists have abundantly proved that the germs of disease are ubiquitous. They are found in earth, air, water; in the dust and on the walls of our dwellings, in clothing, in meat, milk, bread, and even occasionally, as Andrewes has shown, in hot baked rice-pudding. The fact that many of us manage to live to a respectable age, and to die from something that is non-infective, cannot but make us consider whether the immunity of the individual is not the fact which tends more than any other to the improvement of the public health. It is wholesome for us to remember that the greatest sanitary achievement of our time has been the practical disappearance of typhus fever. Of the *causa causans* of this disease we know nothing. Its absolute disappearance has not been produced by successful germ hunting. Its disappearance is probably due to the improved conditions under which the masses of the population live as regards food and cleanliness. Few of us doubt that if this country should become involved in war, and food should become dear and scarce in consequence, the relative immunity of the population would be lessened, and typhus fever would regain its sway. Whether or not we succumb to an infective disease probably depends in great measure on the dose of the poison we receive. When an endemic disease such as enteric fever become epidemic it is due to the sudden dissemination of a poison in relatively large or virulent doses. Even in the most severe epidemics it is rare for more than 10 per cent. of those who have run obvious risks of receiving the poison to be attacked. The questions of virulence and vulnerability are most important. It seems to be well established that the virulence of some of the pathogenic microbes varies immensely with the conditions of soil, temperature, air, sunlight, etc., under which they are grown, and it must be remembered that it is not always the pure cultivation which manifests most virulence. Many infective diseases assume a virulence in the tropics which is rarely met with in temperate countries. This appears to be true of tropical malaria, enteric fever, cholera, yellow fever, anthrax, and tetanus. In hot countries, where a temperature equal to the optimum for the growth of many pathogenic microbes is often continuously maintained for weeks in succession, the risks of contagion and the danger of uncleanliness must often have become apparent in a manner more convincing than among us. The repeated injunctions as to uncleanliness in the Mosaic law, and the rigid rules laid down as to the conditions which made a man unclean and necessitated his subsequent purification, must have been the outcome of experience. To eat with unwashed hands in a tropical country, and without knives and forks, would clearly be to run considerable risks. The regulations in force among the Hindus were even more stringent, and although some of the regulations may appear to us to be extravagant and nonsensical, it is impossible not to admit that most of them have for their aim the protection of the individual and his fellow man from the risks of infection.

There can be no doubt that the health and vigour of the individual is all-important in relation to infective disease. The enervating influence of a tropical climate upon Europeans is recognised as a potent predisposing cause of infective disease, and if to the effects of climate be added those of inordinate fatigue and insufficient food, the risks of infection of the organism are greatly increased. In the Nile expedition of 1889 those troops suffered most which had undergone most exposure and fatigue. Dr. Maclean, R.N. (in a letter to Sir J. Fayrer), alludes to the occurrence of enteric fever in the Island of Ascension, under circumstances of close observation, where no connection could be traced with defective sanitary arrangements, though it is probable that malarial influences did occur. "The water, partly collected from the roofs of buildings during rain and partly condensed, is stored in iron and cemented stone tanks, and removed from all possible sources of contamination." It is of course possible that in a case such as this the bacillus typhosus may be lying dormant in the body ready to assert itself when bodily enfeeblement reaches a certain pitch. It has been asserted—and the assertion received the support of the late Professor Kanthack—that the bacillus typhosus may be found in an abscess years after the attack, and the same thing holds good in a less degree with regard to the microbes of diphtheria and cholera.

Nothing is better established with regard to tubercle than its relation to overcrowding and unwholesome occupations. So "filth diseases" are especially fatal to those who live in the midst of filthy surroundings. It is not, I think, at all necessary to assume, although it is possibly the case, that specific organisms are growing in the filth. In the cramped dwelling of the artisan, where the privy is often barely 6 feet from the back door, the risks of fæcal befoulment of the food or person are very great, and when in such places large pails of fæces are left to putrefy for a week or more, it is not to be wondered at that the inhabitants should show an undue predisposition to the infection of enteric fever as has been pointed out by Boobbyer and others. But it must be remembered that wherever putrefaction is going on, and wherever anaërobic organisms are growing in a filth-sodden soil, unwholesome gases, such as $CO_2$, $H_2S$, $CH_4$, and H, are being given off, and it is impossible not to admit that the breathing of these gases from week end to week end in the crowded courts of a great city may so lower the vitality of the body as to increase its vulnerability to infection of all kinds. We must admit that to live in stinks and filth may greatly depress the health and increase the susceptibility to infection by microbes.

Professor Stewart Stockman[9] reports an investigation which he carried out on a septic organism which proved fatal to 380 fowls out of 400 on a poultry farm. He says: "The most important thing about this bacillus seems to me to be its fatal effect on tuberculosis, while it appears to be non-pathogenic, or nearly so, for healthy birds. It is also interesting to note that it killed a rabbit affected with the coccidium oviforme, although the healthy ones were little affected by it. This observation, I think, affords fresh evidence in favour of what is taught about certain other microbes, namely, that they are only pathogenic to the enfeebled organism."

### DANGER OF WOUNDS.

It is an established fact that infective organisms may gain access to the body through the smallest wound, whether of the skin or the mucous membrane. The various forms of septicæmia as well as erysipelas and malignant œdema are due to this cause.

Tetanus, as we have seen, is always due to the inoculation of a wound, and it is a question whether anthrax of cattle is not more often caused by inoculation of a skin abrasion than has hitherto been suspected. Whether any of our common infective fevers are communicable by accidental inoculation is a moot point, and one which is certain to receive a full share of attention in the immediate future. It is certain that in the transmission of plague a broken skin bears a most important part, and it may be that other infections may be conveyed by the same channel. A distinguished pathologist is credited with having infected himself with enteric fever by a *post-mortem* wound. The infections brought about by flies, ticks, and mosquitos are at present attracting much attention, and it seems probable that the danger of certain "soils" and climates may be shown to be due in an increasing degree to the insects which find in the localities the various conditions necessary for their existence.

It may be that in some instances an abrasion of the skin made by an insect may merely serve as a point of entrance for infective organisms abounding in the surface of the soil or in the immediate surroundings of the individual, and having no necessary connection with the insect itself. It seems certain, however, that in the majority of instances which have been worked out a particular species of insect serves as an intermediary host for a specific organism that affects a specific animal. We hear much about flies conveying fever, which may be true; but we must always bear in mind what I feel inclined to call the excessive specialism of Nature. Insects which feed on dung and carrion are seldom attracted by the food of human beings, and I confess to being somewhat sceptical as to the accidental conveyance of infection by "flies" which heedlessly buzz first into the fæces and then into the milk. The pathologist of the future will clearly have to call in the help of the entomologist.

### PRACTICAL CONSIDERATIONS.

The Maidstone epidemic has been very useful in directing attention to some of the common conditions which endanger water supplies. Pasteur and all subsequent bacteriologists have directed attention to the value of the earth as a filter, and it is a matter of common knowledge that a very shallow layer of compact earth will remove the bacteria and much of the organic matter from water percolating through it.

The greatest danger to shallow wells is to be found in subterranean collections of filthy fluids which leak through fissures in the earth with a gradually increasing hydraulic pressure. The lined well, 5 feet deep, which I have in the middle of my garden, has given water of exceptional purity for years, notwithstanding that the ground is cultivated with human excreta to within 6 or 7 feet of the well. Dr. Macmartin Cameron, medical officer of health for Kirkcudbright and Wigtown,[10] shares my opinion that a "surface well," properly constructed and in a selected situation, is a safe source for water. [The lecturer then referred to Dr. Cameron's observations on the limits of danger and safety in relation to shallow wells.]

Reverting to the conditions which obtained at Maidstone, I will mention a few considerations which, though obvious enough, are often neglected. During a drought such as occurred in June, July, and August, not only would the stiff hop land be liable to crack, but the earthworms would retire to the lowest point in search of moisture. At such times they go deeper and deeper into the soil and lie coiled up in oval knots at the bottom of their burrows. I have upon the table a piece of a worm-burrow removed from my garden in September last at a depth of more than two feet. It is more than a quarter of an inch in diameter, and would act as a drain from the surface to the deeper parts. This question of worm-burrows is one of great practical importance to sanitarians, because, especially after a drought, they may serve to conduct surface water to considerable depths without its really being influenced by that biological filter, the humus. Darwin[11] says that, although worms generally live near the surface, they may burrow to a considerable depth during long-continued dry weather and severe cold; the depth varies with the soil, and may extend to 66 inches.

Then, again, we must not forget the effect of harvest on the soil. Before harvest the amount of moisture retained upon the growing plant and absorbed by the still active root would prevent anything except the heaviest rain from penetrating, although even at such a time one must admit that even half a pint of water, if thrown on a suitable place, might travel *viâ* clay-crack and worm-burrow to a depth of five feet or more. When harvest begins, not only is the earth deprived of its green protecting mantle, but the upward drainage of the root action ceases, and with the falling temperature of autumn and the lessened evaporation the rain has an ever-increasing power of penetrating the soil. In a hop garden the first step in harvesting is the removal of the pole, and the hole thus left is capable of conducting rain water to a depth in the soil of two feet or more. If, therefore, there be open-jointed stoneware pipes in a hop garden at a depth of two or three feet from the surface, it is possible—nay, likely—that when the hop poles are removed a surface channel three or four inches in diameter may communicate with these pipes and a heavy rain may wash solid matters into them from the surface.

If a plant or tree dies, the roots, instead of helping the upward drainage of the soil and preventing surface water from reaching the springs may serve as a direct guiding channel from the surface to the spring. And if the spring be artificially maintained by under-draining it with open-jointed pipes (an operation which involves a considerable disturbance of the ground and its artificial remaking), this danger is considerably increased. Burrowing animals are necessarily a danger in this connection, and if rats or rabbits establish themselves anywhere near the outcrop of a spring they should be exterminated. Rats and rabbits sometimes burrow very deeply, but I have not been able to get any authentic statement as to the maximum depth in the soil to which they may penetrate. When rats crawl from the sewers (their favourite lurking place in towns) to our houses, it is possible that they may be at least as dangerous as sewer gas. Rats occasionally make their homes in dungheaps, especially if such heaps be made in outlying places and are long neglected. It is well known that they invade cornricks in spite of elaborate precautions. It is a safe plan, indeed, to regard the rat as a haunter of foul places and a lover of filth, and its presence as often due to delay in removing accumulation of filth.

The danger of having a catchpit flooded from the surface is one which can easily be guarded against by covering it with suitable structures. The ground above the outcrop of a spring ought to be carefully turfed to a point 6 or 7 feet above the level of the spring. If the water become turbid, or if a worm find an entrance to the catchpit, the use of such water should be discontinued, or it must be boiled and filtered until the cause of the turbidity be satisfactorily demonstrated. Such springs should always be carefully inspected during heavy rains, because it is at such times especially that shallow springs establish surface relations.

The question arises whether it is safe to allow the gathering ground of a spring to be cultivated? This is a national question of the very greatest importance.

Provided there be a fairly thick layer of earth above the spring, I am inclined to think that there is safety rather than danger in the cultivation of the overlying soil. Any spring which is covered by 7 feet of soil—that is, 6 inches more than the depth of the deepest recorded earthworm—might be considered safe from the risk of unchanged organic matter soaking into it from above. In the first place, the cultivation of the land ensures that it is visited more or less frequently by individuals more or less intelligent. A gathering ground for water which is remote from the haunts of man has dangers of its own. Rats or rabbits may burrow in it, and these, as well as other animals and birds, may provokingly die in the runnels which primarily collect the rain water; and I cannot understand how anybody who has ever walked over a moor can maintain the thesis that water running off a neglected waste is safer to drink than that which has percolated through well-cultivated land.

Last year I visited a spring which was, and had been, supplying water of excellent quality for public purposes. It rose in a little copse lying in a natural dell in a remote and seldom visited spot, and was enclosed and protected against surface washings which the configuration of the ground would certainly conduct towards it in times of flood. Some of the trees were dead, and their stumps were permeated with fungi, and one could not but regard it as possible that these rotten roots might serve as conducting channels from the surface to the water which was running beneath to the neighbouring towns. Further, there was evidence to show that this dell was visited by an occasional tramp, and had been made a playground by the children from the nearest group of cottages. It is clear that the non-cultivation of this particular spot was a source of danger rather than of safety to the purity of the spring.

Enteric fever is a disease especially liable to become epidemic in the autumn, when after the removal of the crops the parched earth is soaked, and when there are large accumulations of manurial matters waiting to be spread upon the land. In the summer the yield of springs is seldom increased, no matter how heavy may be the rains. The water which falls upon the earth is all absorbed by the roots of growing plants, and, to a large extent, mounts upwards in the plant to help metabolism and to quicken growth. With the ripening and harvesting of the crops root action ceases, water which falls upon the earth tends more and more to percolate, and when the early frosts have given its deathblow to the greenery of summer, then the springs begin to yield more water. The nitrification and final solution of organic matter in the soil goes forward mainly, if not entirely, in the upper layer, and it is doubtful if any appreciable amount of oxidation takes place in the parts which are beyond the reach of tillage. A certain proportion of the mineralised organic matter necessarily escapes absorption, and percolates with the water, and if there be much unused nitrates remaining in the soil after harvest, the amount which percolates to the springs may be considerable. If nitrates be placed upon the soil in the form of artificial manures, they are often dissolved and washed beyond the reach of plant roots by the first heavy shower. Not only nitrates, but soluble salts of ammonia, are placed on the ground in large quantities, and the presence of free ammonia in the drainage water of cultivated land that has been artificially manured need not be an indication of pollution in the proper sense. It must be very hazardous to draw just conclusions as to the wholesomeness or otherwise of water from the amount of nitrates in it.

REFERENCES.

[1] Lecture I was published in the BRITISH MEDICAL JOURNAL of February 25th. [2] *Croonian Lectures*, 1898. [3] *Lancet*, August 20th, 1898. [4] Local Government Board Report, 1897-98. [5] BRITISH MEDICAL JOURNAL, January 8th, 1898. [6] Local Government Board Report, 1867. [7] *Arbeiten aus dem Kaiserlichen Gesundheitsamte*, vol. xii, f, 11, p. 448. [8] *Annales d'Hygiène Publique et de Médecine Légale*, Troisième Série, t. xxxvii, January, 1897. [9] *Veterinarian*, September, 1898. [10] BRITISH MEDICAL JOURNAL, August 13th, 1898. [11] *Vegetable Mould and Earthworms*, p. 111 *et seq*.

REGULATION OF THE SALE OF POISONS IN NEW YORK.—A Bill has been introduced into the New York Legislature, requiring druggists, pharmacists, manufacturers, and wholesale or retail dealers who shall sell any proprietary medicine containing poison or poisons in any form, to put it in "such bottles or packages, of such size, shape, or condition as to give notice of its contents." Failure to do so is made a misdemeanour. The *Medical Record* says such an indefinite law as this would accomplish nothing, and it is safe to assume that the Bill will never pass the Legislature.