THEORY OF THE MECHANISM OF ZYMOTIC DISEASES.

THE most recent advances in biological research afford a basis on which to erect a more or less plausible theory of the mechanism of diseases caused by micro-organisms.

The domain of parasitism is far wider than has hitherto been accepted. The principles of evolution teach us life is one; living forms being but strands in a complicated web, no single fibre of which can assert its independent genesis and history from any other fibre however remote, while each of these forms possess a greater or less antagonism to other forms. So it would appear a large proportion of the maladies, whether in plant, fish, reptile or mammal is produced by parasitism—the antagonism of lives—the lesser lives feeding on the greater. The higher animal organisms are but communities of living points, some floating free, others stationary—these last attached to their neighbours by protoplasmic bonds of marvellous tenuity, just as adjoining households may have telephonic connection but with their individuality and their automatism unimpaired. A colony of inimical microbes obtaining access to this republic is similar to a hostile armed band entering a city—strife at once commences, the strangers attack and are attacked. If the strangers are all killed, no disturbance of health is produced; in any other event, the strangers increase and multiply at the expense of the normal inhabitants, the latter being rather destroyed by some special soluble toxic substance excreted by the enemy than in any other way.

Each micro-organism seems to have a particular rate of multiplication, and when a sufficient quantity of toxic material has accumulated, then the phenomena of fever and eruptions are produced. So far as experimental research has gone, there is no true incubation; there is no mysterious localization of the invading band in lymphatic gland or vessel for days or weeks. The battle at once commences, but it is only when a certain number of the strangers have got the upper hand that a sufficient disturbance of function is produced to give external sign.

In the case of the individual little mass of bioplasm, a few hours may represent several generations, so that acquired properties are very rapidly transmitted; those poisoned by the excretion of the pathogenic microbes perish, those that more or less effectually resist continue to live and propagate, until, by a repetition again and again of this process, the body may be full of resistant living particles. In that case the foreign tribe is conquered, destroyed, expelled, and what is called recovery takes place.

If now a second colony gain access to the same animal tissue, it meets with descendants of the old heroes, and the attack is immediately repulsed. This is the nature of protection from a first attack

Vaccination is but a modification of the same process. Colonies composed of the weaker members of some malignant tribe enter the citadel, a brief struggle ensues, the inhabitants finally destroy them, and the education thus acquired renders the inhabitants able to cope with a second stronger colony. This second successful fight renders the survivors and their descendants still hardier, and so the process may be repeated until they are able to easily resist the strongest and most virulent of their assailants. This is the phenomena of protection by inoculation of attenuated cultures.

Lastly, it would seem from the experiments of M. Roux and others that the living points of the animal organism may be educated in resistance by being dosed with the excretory products of pathogenic organisms, and that the inoculation of attenuated organisms is not necessary; if this is so it would in no way alter the conception of the mechanism of immunity—that is, it essentially depends on the production of a sufficient number of resistant masses of bioplasm, this resistance having been acquired by inheritance from ancestors who have made successful combats against a particular microbe, just as the descendants of Dr. Dallinger's saprophytes were ultimately able to live at a temperature of 158°F.

SMALL HOSPITALS FOR THE ISOLATION AND TREATMENT OF INFECTIOUS FEVERS, ESPECIALLY IN RELATION TO ASYLUMS.

By RICHARD GREENE.

(*Medical Superintendent of the Berry Wood Asylum, Northampton.*)

THE Commissioners in Lunacy have lately recommended the erection of detached hospitals for the treatment of infectious disease at most of the English County Asylums, and it would seem that at least twenty of these institutions are already equipped in this matter. These hospitals differ greatly as to size, form of construction, adjuncts, distance from the main building, and, in fact, in all their features. Some resemble villas rather than hospitals, others are attached by corridors to the asylum. The most of them are of one story only, but one or two are of two stories. Some are divided into blocks, others are in one continuous building. The causes of this endless variety are, firstly, that there are no model plans of asylum hospitals published, and, as far as I am aware, no plans published at all, if I except that lately built at the East Riding Asylum; and, secondly, that these hospitals being for the most part small affairs, architects are rarely invited to send in plans, so that there is a total absence of the stimulus of competition.

The plans are generally prepared by the County Surveyor, who may, or perhaps more frequently may not, have had previous experience of hospital construction, and who sometimes receives help from the medical superintendent.

The Scotch Lunacy Commissioners exhibit plans of what they look upon as model asylum buildings : but it may be doubted whether much is gained thereby. It may show an architect in which direction he ought to work, and so do good, or it may have a tendency to cramp originality and prevent a careful study of other buildings, and so do harm.

In the following pages I intend throwing out some suggestions for the consideration of those who may be entrusted with the planning of small hospitals. Most of these points have been carried out in the one erected in 1886, at the Berry Wood Asylum, and of which the Commissioners remark, in their report to the Lord Chancellor, that, "it is very suitable for its purpose."

(1). The form of the asylum estate will usually decide the distance of the hospital from the main building and its relation thereto. Probably about one hundred yards would be found the most convenient distance ; but, where this cannot be got, very much less would suffice. In one of the old London Small-pox Hospitals the boundary wall was within a few yards of the adjoining houses, and I am assured that the disease was never once known to jump the fence. In nine cases out of ten small-pox is the disease which will have to be treated, as other infectious fevers are but rarely seen in asylum practice.

When possible the hospital should be within sight of the front entrance to the asylum. The superintendent's office is generally in this position, and it is a matter of much importance to have a detached building where it can be commanded from the windows of the medical superintendent's office, whether such building be used for infectious disease, or, as is often the case, for harmless patients when not wanted for its proper purpose.

(2). The size which the hospital ought to be is not a very easy question to settle ; but it would seem tolerably certain that it need not bear any close relation to the size of the asylum to which it is to be added. Should the disease be limited to the case first infected, the smallest possible hospital would be enough for isolation of that case ; while if the disease spread much, the largest hospital yet built at any asylum, except, perhaps, that at Stafford, would be insufficient to cope with it. This statement is not a reason for unduly limiting the sleeping accommodation, not only because cramped space would prevent the use of the hospital as a cheerful residence for chronic or convalescing lunatics, but also because the administrative department has to be almost if not quite as large for, say, eight cases as it has for double the number. The mere extension of the dormitory does not mean much addition to the cost. For instance,

in the plan here given, the accommodation might have been increased fifty per cent. by an expenditure of about twelve per cent. on the whole cost of the hospital.

In the event of the disease spreading, the building must be looked on as a centre containing an administrative department and rooms sufficient for the treatment of the first cases—a nucleus around which tents or wooden sheds can be ranged. The latter plan was adopted at the Three Counties Asylum, where the hospital was speedily filled ; and also at the Berry Wood Asylum. Here a wooden shed forty-five feet long and sixteen feet wide was commenced on a Friday afternoon and occupied by patients on the following Monday ; and, I believe, the additional rooms at the Three Counties Asylum were erected equally as quickly, so that no difficulty need be anticipated in that direction. But kitchens, bath-rooms, disinfecting-rooms, laundries, boiler-houses and so on cannot be built hurriedly, so that whatever size the dormitories may be, the administration department should be completely equipped and large enough to resist any sudden strain to which it may be subjected.

Probably the most usual size is between twelve and eighteen beds. The cubic space per bed considered necessary varies much. In some cases one thousand or twelve hundred feet only are allowed. In others fifteen hundred are given ; but it is manifest that nothing short of two thousand should be thought of, and even this allowance is totally insufficient for severe cases of confluent small-pox. Of course much will depend on the construction of the ward and on the system of ventilation.

The dormitories, of which there must be two, one for men and one for women, may be of almost any length, but never less than twenty-two feet wide. In height fourteen feet would be enough, but fifteen would be better. There ought to be one single room on each side. It should be of larger size than ordinary single-bedded rooms, but otherwise constructed similarly. Rooms for two day-nurses and for two night-nurses should be provided, and also suitable accommodation for the kitchen and laundry servants, so that if need be the hospital can be worked independently of the parent institution. It is desirable to have the ward store-rooms of large size in case it should be necessary at any time to find room for extra nurses.

(3). The bath-rooms should adjoin the dormitories, but ventilating passages must separate them from the latter. It is the more necessary to insist on this, as one of the most recently constructed asylum hospitals has its bath-rooms opening direct into the dormitories, in which position they not only block out wall space, which should be used for light and air, but permit steam and noise to find their way from the bath-rooms to the dormitories. The w.c. blocks should also have cross-ventilating passages, and they should never open off the main corridor, as in at least two English asylum hospitals.

DETACHED HOSPITAL, BERRY WOOD ASYLUM,
NORTHAMPTON.

GROUND PLAN.

(4). Although not absolutely necessary small day-rooms are very desirable. They are useful when fever patients begin to leave their beds, or, should the dormitory beds be all filled, they can be fitted up as auxiliary dormitories.

(5). The ordinary double-hung sash windows answer perfectly well provided there are hopper fanlights opening inwards. Without these fanlights there is apt to be a deficiency of cross ventilation, as it is not always safe to have asylum windows made to open more than five or six inches. In the dormitories the windows must be placed opposite to each other as in hospital pavilions, and each bed should have a window on either side of it. These admit of no exceptions. The windows are best if made longer than usual, so that the hopper fanlight may be as close to the ceiling as possible, and the sills not more than two feet three from the floor. Windows at the end of a dormitory always look well, and when the ward exceeds forty feet they should never be omitted.

(6). For the sake of light, cheerfulness, and facility of observation, the upper panels of all the doors should be of glass, and it is a good plan to have the lower panels of trellised ironwork, by which means fresh air can be admitted close to the floor line. In very cold weather these panels may be closed by small wooden shutters. Fanlights, hinged or on swivels, are useful over the doors. There ought to be no mouldings on the doors or architraves, and indeed all projections likely to harbour dust should be reduced to a minimum.

(7). The floors are best made of oak, but pitch pine or even yellow deal would do. In any case it should be thoroughly well-seasoned to prevent the least shrinking. The boards ought to be tongued and grooved, and when being laid a layer of whitelead or thick paint should be placed between their edges so as to completely fill the interstices. The boards should not exceed four inches in width, and they should be skew-nailed. If of soft wood they can be made fairly impervious by the application of two or three coats of varnish.

(8). The inside of the walls, or at least a dado five or six feet high, should be finished in Parian or Portland cement, or, what is perhaps preferable, the dado may be made of glazed bricks laid and pointed with cement. Either of these permits of frequent washing.

(9). In our English climate open fire-places are incomparably the best means of warming, and in a ward fifty or sixty feet long a fire-place at each end will be quite sufficient provided they are properly constructed. The tubular fire-place and the Manchester grate back are useful means of introducing a considerable amount of warmed fresh air into the room. There is no reason why the passages should not be warmed by slow-combustion stoves, or by coils of steam or hot-water pipes. The single bedded rooms may be so arranged that they can

obtain heat from the corridor stoves. This plan has been adopted in the East Riding Asylum Hospital, and it is perfectly justifiable to utilize such heat for single rooms because open fires cannot always be safely employed in them. It is a less evil than excessive cold. But wherever practicable the open fire-place should be relied on in all parts of a hospital habitually used by patients, because the rays from an open fire resemble those from the sun in passing through the air without appreciably warming it, while enclosed stoves or coils of pipes actually warm the air. Hence, when the latter system is in use, the patients are compelled to breathe the same air which warms their bodies, a proceeding both unnatural and injurious. Doubtless air may be warmed up to a certain point without perceptible injury to those who inhale it. What that point may be I am not aware, but I am inclined to think it is much lower than is generally supposed. Certain it is that healthy men may breathe air of almost any degree of coldness provided the surface of the body be kept warm by clothing or exercise, and the cool sea breeze brings health and life while the hot air from the desert brings disease and death.*

To warm a building is not difficult, and to ventilate it is not difficult; but to both warm and ventilate it at the same time is not always easy; and the presence of the sick and insane forms a disturbing element in all calculations concerning temperature and fresh air. In many of the insane the nerve-force is low; consequently they are unusually susceptible of the ill effects of low temperature and of vitiated air. The results of the first are soon apparent, and the second, although more insidious, are not, therefore, less destructive.

Many interesting facts concerning asylum hospitals are to be found in a pamphlet, printed I think for private circulation, by Dr. Sheldon of Macclesfield. It would seem that the smallest hospital contains six beds, and the largest eighty-five, while the cost varies from £820 to £8,000.

In comparing the cost of different hospitals the mere number of beds is a most fallacious criterion, not only because the cubic space per bed differs so much; but also because the administration departments and the adjuncts are not alike in any two hospitals. Before any just comparison can be made, it is necessary to know the entire cubical contents and also to have some idea of the specification.

That at Berry Wood cost £2,700, and it cubes out a little under fourpence per cube.†

It consists of a centre and three blocks. [*See plan.*] The west block is for men; the east for women, and the north block contains the administration offices. The centre is formed by a porch, ten feet by nine; the connecting corridors, seven feet wide, and at the union of these springs a tower, fifty feet high.

* See Stevenson's work on architecture.

† The lowest tender was £2,649, but the extras brought the total up to the sum named.

This tower is chiefly ornamental, but is useful to some extent as a ventilating shaft, and it contains an alarm bell. It is also fitted up with dials for showing the direction of the wind, and a lightning rod is attached to its highest point.

The east wing can be shut off from the rest by a door having master locks. It contains a store-room, twelve feet by eleven feet three, a single-bedded room, twelve feet by twelve feet, a nurse's room of the same size, a day room, twenty-two feet by twelve, without the bay, and another nurse's room, twelve feet by twelve. The dormitory is forty feet long by twenty-two feet wide, and is fourteen feet high. It is intended for six beds and provides rather more than two thousand cubic feet per bed. The bath rooms and w.c. blocks project from the extreme corners of the dormitories. The connecting passages are cross ventilated, and open louvres in the roofs of bath-rooms and w.c.'s increase the means of ventilation, as also do small gratings on the floor line.

The dormitories are warmed by open fire-places having tubular backs, and similar grates are fitted up in the two rooms adjoining, the warm air being delivered into the dormitories. The rooms are ceilinged as in an ordinary house at the level of the upper edge of the tie beam, this plan seeming preferable to the other, which is likely to be somewhat cold in winter and warm in summer. The roof space is, however, utilized by four gratings in the ceiling of each dormitory, and a Boyle's extractor is placed in the roof with the object of drawing off the vitiated air. Sun-burners are used for lighting the day-rooms and dormitories, and four-inch pipes connect the burners with the chimney flues.

It should be stated that the piers between the windows are hollow. The fresh air is admitted from the outside by large "hit-and-miss" gratings, and openings in the cornice permit it to fall in a gentle spray in similar manner to that of a Tobin's tube.

A dado of glazed bricks surrounds the dormitories, bath-rooms, closets, and the passages leading thereto.

The west wing is in all respects a copy of the east.

The north block contains rooms for the laundry-maids, ironing room, drying closet, and wash-house. At the opposite side are the cook's room, kitchen, larder, back kitchen, scullery, and coal place. These form the east and west sides of a square; the south side being formed by the cross-corridor and the north by the disinfecting room, boiler house, and dead house.

ASCARIS LUMBRICOIDES.—In a short article contributed by Prof. Battista Grassi to the *Centralblatt für Bakteriologie Parasitenkunde*, III. Bd. No. 24, 1888, the author refers to an auto-experiment, in which he swallowed 100 round-worm eggs on the 20th July, 1879, which he had obtained from the intestinal canal of a corpse on October 20, 1878. On August 21 he first found he was slightly affected with round worm.

THE PREVALENCE OF DIARRHŒA IN LEICESTER.

(The following is an abstract of a report made recently by DR. HY. TOMKINS, Medical Officer of Health to the Borough.)

IT has been shown more than once that Leicester, as a manufacturing town, is much on a par with other towns of its class, so far as pertains to the care and rearing of its infant population, among whom the mortality chiefly occurs. But the time has come to take a much larger view of this disease, and not to confine attention merely to the infantile portion of the community. We possess ample statistics now, to show that all ages, classes, and occupations are attacked.

Out of nearly 10,000 persons known to have suffered during the past summer, almost two-thirds were 20 years of age and upwards. I showed last year that the disease prevailed more extensively in certain districts of the town, and this district I have called the "Diarrhœa Area."

During the summer of 1887, I have chiefly been occupied in carrying on bacteriological observations as to the existence or otherwise of an excess of microscopic forms of life, or micro-organisms and their spores, in the air of the various parts of the town, and they have generally speaking served to confirm the results obtained in the summer of 1886.

In this work, I have made use chiefly of Hesse's apparatus for the examination of air, employing as the media for cultivations, nutrient gelatine, either neutral or with a slight trace of free acid. I have examined the air in Woodboy Street, Waring Street, Victoria Park, Bonner's Lane, Russell Square, Asylum Street, and All Saints' Open. Without going into detail, the results briefly were as follows, the tubes in which the growths developed being all kept at about the same temperature, namely, from 63° to 65° Fah., and in every instance three litres of air were operated on.

	Day from collecting air.	Total organisms in 3 litres of air.	Bacterial Forms.	Moulds.
1st series.	Woodboy Street. On 6th day	32	19	13
	Waring Street ... "	10	5	5
	Victoria Park ... "	21	7	14
	Bonner's Lane ... "	29	15	14
	Russell Square ... "	13	8	5
2nd series.	Asylum Street ... 3rd day	20	14	6
	All Saints' Open. 4th day	14	8	6
	Russell Square ... 5th day	25	17	8

It is probable that the bacterial micro-organisms are of much more importance than the ordinary common moulds, the spores of which always exist in the air. Looking at the former only, it is seen that they varied in number from upwards of 6,000 per cubic metre to only about 1,600 in Waring Street and 2,300 in Victoria Park: these two latter localities being, as you are aware, outside the

"Diarrhoea Area." It will be noticed that Russell Square is recorded twice. In the first series, just before the observation was taken, a heavy thunderstorm came on, and only eight bacteriae were found present, whilst at the same spot, two days after, no less than seventeen were present, agreeing more closely with former observations in this district. This is rather an important fact, and looks as though the rain, in addition to cooling the air, washed down with it a large number of its microbes and their spores.

Besides the simple statement of the number of organisms found, other particulars require to be stated, the significance of which will be fully appreciated only by those who have some special knowledge of bacteriology. I allude to the different

Asylum Street this process had by the third day arrived at this stage, in that from All Saints' Open on the fourth day, and in the second sample, from Russell Square, on the fifth day.

Further, this liquefied gelatine was now converted into a dirty-looking, offensive-smelling fluid swarming with micro-cocci, in chains and masses, together with some short baccilli, apparently much less in number.

The tubes taken from Waring Street and Victoria Park remained free from liquefaction to a large extent, and had a much less offensive odour.

Cultivations were made from this liquefied material in the usual manner, with a sterilized needle, into gelatine tubes, with the following result :—

results of the action of these growths upon the nutrient material. It will be seen that in the first column a day is denoted: this refers to the last day, from the time of passing the air through the apparatus, on which the final enumeration of growths was made.

In fig. *a* (illustrated on this page), these growths are represented, the tube being drawn to half scale.

In each of those tubes in which the air had been obtained from Woodboy Street, Russell Square, Bonner's Lane, Asylum Street, and All Saints' Open, towards the fourth day the nutrient material showed signs of liquefaction, so that after the sixth day it was not possible to count or properly distinguish the separate growths. In that from

The needle was inserted into the nutrient media to the depth of something over half an inch, and the tubes were kept at a temperature of about 65°. On the second day there was a slight opalescence visible along the needle track; on the fourth day there was a small white patch on the surface, and the needle track was distinctly visible, as shown in fig. *b*; by the sixth day it presented the appearance of fig. *c*; on the ninth day the whitish patch on the surface had spread, and the gelatine was becoming liquefied in the cup-like manner seen in fig. *d*. This process of liquefaction proceeded steadily until the depth to which the needle had been inserted was reached, so that on the twelfth day the appearance was that

represented by fig. *e*. It then stopped, or proceeded so slowly, that in four more days but little change was apparent to the eye. The tubes were then opened, and the same offensive odour was found to be present, though not quite so strong as that in the Hesse's tube from whence they had been inoculated. In like manner, as described last year, exceedingly small quantities of this infected liquefied gelatine, swarming with the micro-organisms mentioned, sufficed, when taken into the system, to induce a smart attack of diarrhoea, lasting several hours.

The micro-organisms of the second cultivation were, for the greater part, micro-cocci of considerable size, but they presented no special morphological appearance to distinguish them from many like organisms of this kind.

Whether the presence of one or more of these microbes in the atmosphere be the direct cause of this summer diarrhoea or not, I think it can be abundantly demonstrated, both by a process of exclusion and from positive evidence, that it is *due to something in the air*, which exists only, or more abundantly after the onset of the summer heat, and which also, whatever it may be, is at work more actively in some districts than others.

That the cause is one common to and affecting all ages, classes, and occupations we know; therefore it cannot be causes which some observers have thought, such as teething, improper food, maternal neglect, congenital debility, and the like: these affect infants only, and are at work the whole year round, whilst this disease exists for only a very limited and well marked period. By the same reasoning, it is easily shown that many other supposed causes cannot be the *causa vera*.

Up to the present time, our actual knowledge has not gone beyond the fact that whatever the direct cause, an *increased temperature* is the one condition without which the disease does not develop.

But that *heat alone* is not the *only* essential factor is also proved. The summer temperature of this country does not vary to any considerable degree in towns adjacent to one another, and yet the difference among them in the prevalence of and mortality of diarrhoea is enormous.

That it is not due to any special constitutional tendency of those who dwell in Leicester is well seen by the following:—During the past three summers, *i.e.*, 1885, 1886, and 1887, I have had under my care at the Fever Hospital large numbers of children. During the summer of 1885 the weekly numbers in the wards ran from 100 to 150 patients, in 1886 from 50 to 70, and in 1887, from 12 to 20. The bulk of these were children, all from the Borough, and largely from those parts of the town where diarrhoea most prevails. The Hospital is situate well outside the limits of the Borough, on rising ground. The temperature registered here was the same as that

in the centre of the town, and yet diarrhoea was practically absent amongst the whole of these large numbers; ample evidence that it is *not heat merely* that is required to produce it. Again, amongst my own personal acquaintances, during last summer, in more than one instance, those with a family of young children, who had suffered severely in former years from the disease, took them only a few miles out of the town to an elevated rural district, before the heat of July commenced, with the result that they entirely escaped any attack whatever, although, as far as the thermometer is concerned, the temperature was practically the same as in Leicester.

With the above facts before us, I will endeavour to shortly place before you what, so far, are my own conclusions upon this intricate problem; and here it is necessary for a few minutes to look into the past records of Leicester, and see what light from these may be thrown upon it.

(Dr. Tomkins then proceeds to trace the history of diarrhoea in Leicester, proving from the statistical records that it was not until 1850 that the deaths in the third quarter of the year were in so large an excess of the second quarter, but since that time this increase had gone on continuously, and without interruption. This increase he refers to pollution of the soil and air chiefly from the former condition of Leicester, the town so late as 1872 being known to possess between six or seven thousand open privy cesspools.)

Speaking generally, Leicester is situate upon clay, beneath which lies the new red sandstone; but following the bed of the river for a variable distance, on either side, alluvial deposit is found, consisting of sand, gravel, etc., of a varying thickness, from the river townwards. This does not extend much beyond High Street and Belgrave Gate. Overlying all, of course, is a variable amount of soil. What I now wish to lay stress upon is this, that from the above causes the whole of the subsoil of the inhabited part of the town has, for something like half a century at least, been almost constantly polluted in the manner described. In those parts where the clay comes near to the surface, the small covering of soil has had scarcely any chance to purify itself, while in those parts where the more porous gravel and sand overlies it, until very lately the periodical flooding by the river, and overflow and leakage from imperfect sewers, has sufficed to keep it more or less constantly contaminated.

I think I am justified in stating, therefore, that the subsoil of the Borough is, and has been for a long time past, in a polluted state, and in many localities actually sewage-sodden.

It is to be borne in mind that all superficial soils contain a considerable amount of air, and that this subsoil air is constantly moving, under the influence of varying meteorological and climatic conditions.

Amongst the mass of information acquired in

recent years, by scientific workers, in connection with the development and life history of the lowest known forms of living organisms, one of the most elementary facts is, that given dead organic matter, plus warmth, and these microscopic forms of life increase and multiply to an extent almost inconceivable.

Many of my predecessors, or probably more correctly, I should say, all who have gone before me, in endeavouring to find the true explanation and cause of Leicester's excess of diarrhoeal mortality, have attributed to an increased temperature the most important position as a causative factor, though the manner in which heat brought about the disease has been matter of much diversity of opinion. Many and elaborate records have been taken in various parts of the town of the daily maximum, minimum, and mean temperature, and the broad fact came out that, soon after the maximum temperature reached 60° to 65°, then the disease commenced.

I believe, however, that not sufficient attention has been paid to other points in connection with the temperature, and more especially, as it affects other matters besides the atmosphere. All the above are records of the *air temperature only*, which is liable to very sudden changes from many causes; and further, they give no information as to the length of time during which the maximum temperature existed on any given date: it may have been for a few minutes only, or for several hours daily. In the *temperature of the earth*, we have, however, a much more stable factor to do with. The soil will become heated in proportion to the length of time that the maximum heat of the sun plays upon it, and, of more importance still, its temperature will not fluctuate so rapidly as the temperature of the air does; but when the heat has penetrated one or two feet into the ground, it will be retained for comparatively long periods of many hours. I have, therefore, specially considered the earth temperature.

(Dr. Tomkins next proceeds to give a table showing the mean and maximum air temperature, and the earth temperature at depths of one and four feet respectively, in the months of June to October, for three consecutive years, 1885, 1886, and 1887, and the deaths from diarrhoea in each of the months.)

Taking a broad view of the above records, to my mind the conclusion to be drawn from a consideration of them is, that soon after the temperature of the earth, at a depth of one foot, has reached 59° to 62°, the causes producing the disease begin to operate. We do not, it is true, find the same exact coincidence in the decline of the disease with the fall of the earth temperature, for a few deaths are recorded when that has fallen to 54° or even lower; but I think this is easily explained by the fact that some cases will run a more prolonged course than others,

and may not prove fatal until some time has elapsed from the first onset of the attack.

Or, again, it is quite easy and logical to suppose, that the causes having once been set in operation, should persist for some little time after the conditions which resulted in their production have ceased to exist.

It may be noted here that during the months of July, August, and September, I have had the temperature within the sewers taken daily, in six different parts of the town. As might be expected, where the ventilation of these was most free, the temperature within them was approximately in accord with that of the external air; but the maximum temperature registered was always something below, whilst the *minimum temperature was usually above that of the external air*, so that the mean temperature for the twenty-four hours was higher.

The minimum temperature in any of these did not fall to 53° until after the end of September, and was until that time more often nearer to 60°.

It is notorious that, in all the low-lying districts of the town, the present sewers are more or less foul, with gradually accumulating deposits from their contents. This offensive material, acted upon by a temperature of 60° and upwards, furnishes all that is required for an active development of microbic life.

Actual examination of the sewer air shewed that, in the worse parts, these microbes were largely in excess compared with the external air.

We have long known that different species of microbes, or bacteria, have different temperatures at which they best grow and develop, and that the germinal vitality of them and their spores is very dependent upon the temperature by which they are surrounded, being much reduced and held in abeyance by cold, but ready at once to take on renewed vitality when again subjected to the influence of warmth.

Sternberg (*International Journal of Medical Sciences*, July, 1887,) gives the result of some experiments undertaken to ascertain the temperature at which different pathogenic organisms were absolutely killed and destroyed. The thermal death-point, as stated by him and others, varied much for different species: thus the *Spirillum Cholerae Asiaticæ* was killed at 52° C., the *Spirillum Finkler-Prior* at 50° C., the *Streptococcus Erysipelatus* at 54° C., and the *Vaccine virus* at the same temperature; whilst the virus of *Hydrophobia* required a temperature of 60° C., the *Staphylococcus Pyogenes Albus* 62° C., *Sarcinia Lutea* 64° C., and the *Anthrax bacillus*, with its spores, was not destroyed at a less temperature than 100° C.

These and other facts prove that with microbes, as with organisms of larger growth, whether vegetable or animal, certain temperatures are most favourable for their development and life.

I have attempted, in this and former reports, to show that the air of the town, in certain districts,

contains more germs than in others, and that in these same districts diarrhoea prevails most. I have pointed to a condition of things whereby, for many years past, a pollution of the soil, etc., in these districts especially, has been going on. Given, therefore, this polluted condition of much of the area upon which the town is built, we have, under the influence of the sun's rays, in the heat of summer, sufficient cause for the production of enormous numbers of micro-organisms and their germs. My own experiments demonstrate that the most favourable temperature for the artificial cultivation of these aerial organisms is somewhere between 60° and 65° Fah., and I have some evidence to show that these artificially-cultivated microbes have the power to produce diarrhoea in any person swallowing them.

Without doubt another contributing factor, and possibly a more important one than it has usually been considered, is the geographical position of the town: lying, as all the older part of it does, low down in the valley of the Soar, the direction of the valley, too, being such that the prevailing winds do not sweep along it but rather across it, so that in the summer months what little breezes may be blowing affect but slightly this part of the town, which lies baking in the heat of the summer sun; its old and narrow streets, and many of its newer ones also, with their long lengths of unbroken rows of cottage property, having scarcely a breath of fresh air to be felt in them; all these conditions, instead of helping to mitigate the effects of a polluted atmosphere, are powerful aids to and accelerators of the evils induced thereby.

To summarize, I would submit that—

- (a) In the earliest mortality statistics of Leicester, we find no marked excess of deaths in the third quarter of the year, such as we find since 1850.
- (b) We may therefore conclude that diarrhoea did not formerly produce the mortality it does now, and presumably, therefore, did not prevail so extensively as now, during the summer season.
- (c) There is ample evidence of a continued pollution going on since that time, producing a condition of soil, etc., eminently favourable to the development of bacterial forms of life.
- (d) That the disease appears annually when the earth temperature has reached a certain point, and declines as this declines.
- (e) That, in those districts of the Borough where diarrhoea is most prevalent, the air is most contaminated with microbes or their germs and spores.
- (f) That these same microbes, when artificially cultivated, possess the power of inducing diarrhoea in the human subject.
- (g) That the results are all intensified by the local position, etc., of the town.

Whether the geological formation of the district has any special significance in this enquiry, I cannot say. This is a point which can only be elucidated satisfactorily by a more comprehensive enquiry, extending through the country at large, and comparing towns where diarrhoea prevails with other towns where it is but little prevalent. It is thus that much useful information may be looked for from the report, which was stated in the House of Commons will soon be forthcoming, as the result of the prolonged and extended investigation, going on now for some years, not merely at Leicester, but in numerous other places, by Drs. Ballard and Power, of the Local Government Board.

It is only by such an extended investigation that many of the points enlarged upon in this report, as being probable causes of the undue prevalence of the disease in Leicester, can be confirmed or confuted.

In the meantime the practical point that concerns us is, what can be done to diminish it, and what are the prospects of its reduction in the future.

I am inclined to take a somewhat hopeful view. If what I have laid before you in this report be based upon fact, we may fairly hope that as improved sanitation, or in plain English, more cleanliness, cleaner sewers, cleaner soil (for the soil has a natural tendency to purify itself if allowed a fair chance), a cleaner river, absence of flooding and polluted house basements, together with cleaner houses and habits of the people, and extended education among the poorer classes, yearly make headway, the evils inseparably attached to the low-lying position of the town may be to some extent combated and neutralized, instead of, as in the past, increased tenfold, and that thus the annual scourge of this otherwise healthy borough may be very considerably abated.

A SUFFICIENT WATER CLOSET.—*St. Pancras Vestry v. Fairchild.*—This case was heard before Mr. Bros at Clerkenwell Police Court on May 8th. The defendant had neglected to comply with a notice to provide additional w.c. accommodation. It was held that one water closet was not "a sufficient water closet" under sec. 81 of the Metropolis Local Management Act, 1855, for twenty adults and twelve children, members of different families living in the same house. This decision is important, the Vestry not having adopted the Bye-Laws for "Houses let in Lodgings." Evidence was given in the case to show that the Model Bye-Laws of the Local Government Board for Houses let in Lodgings require the provision of one water closet for every twelve persons; and Bye-Laws under the Common Lodging Houses Act, with separation of the sexes, require one closet for every twenty persons; also that it is possible to construct a water closet to accommodate more than one person, as in factories where the trough system is adopted. A penalty of 50s. and 2s. costs was imposed, the work being commenced at time of hearing.