Taylor (L. H.)

With compliments of
the Author

REPORT

UPON THE

EPIDEMIC OF TYPHOID FEVER,

—AT—

PLYMOUTH, PA.

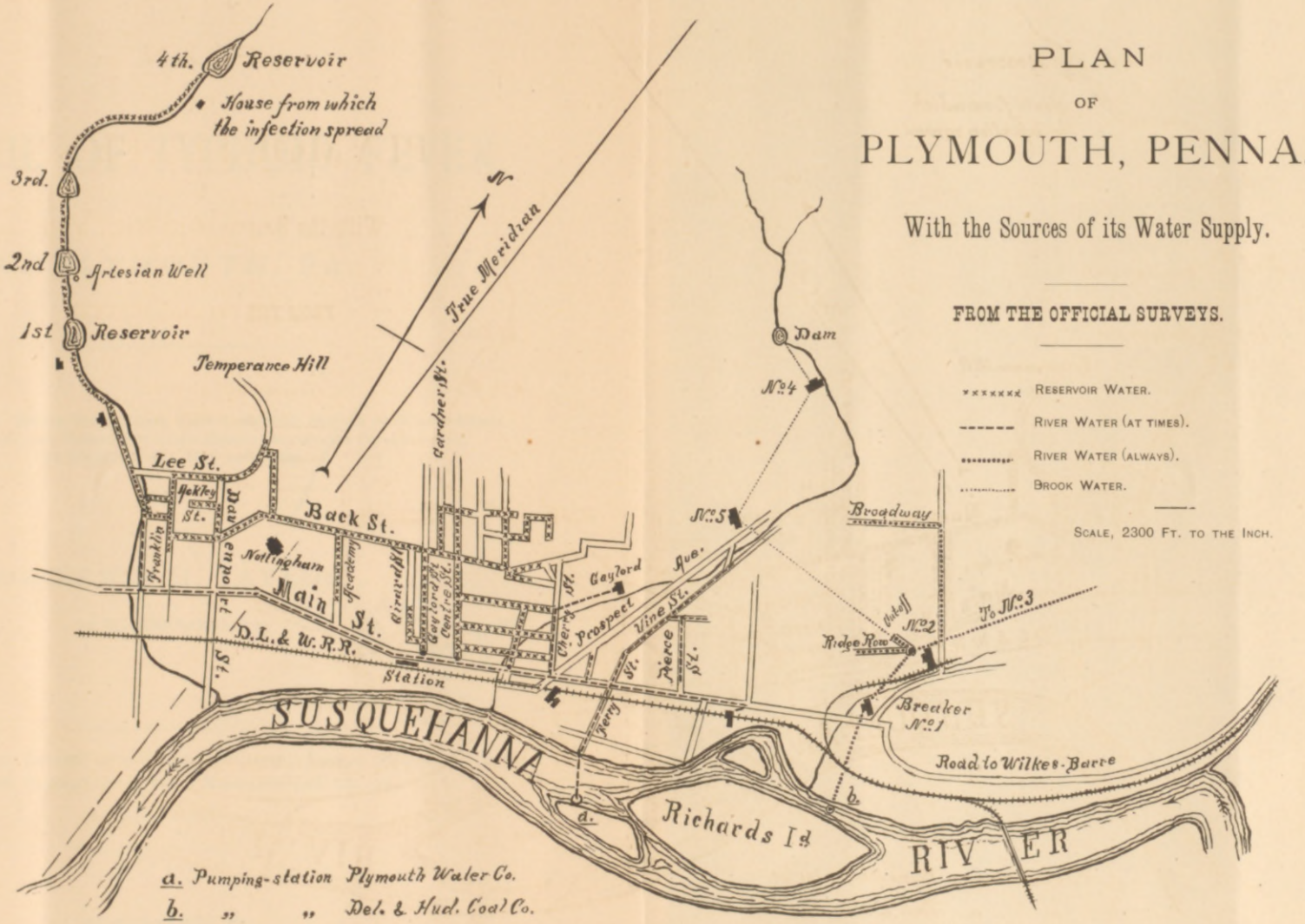
—BY—

DR. LEWIS H. TAYLOR,

OF WILKES-BARRE, PA.

PLAN
OF
PLYMOUTH, PENNA.,
With the Sources of its Water Supply.

FROM THE OFFICIAL SURVEYS.



RESERVOIR WATER.

RIVER WATER (AT TIMES).

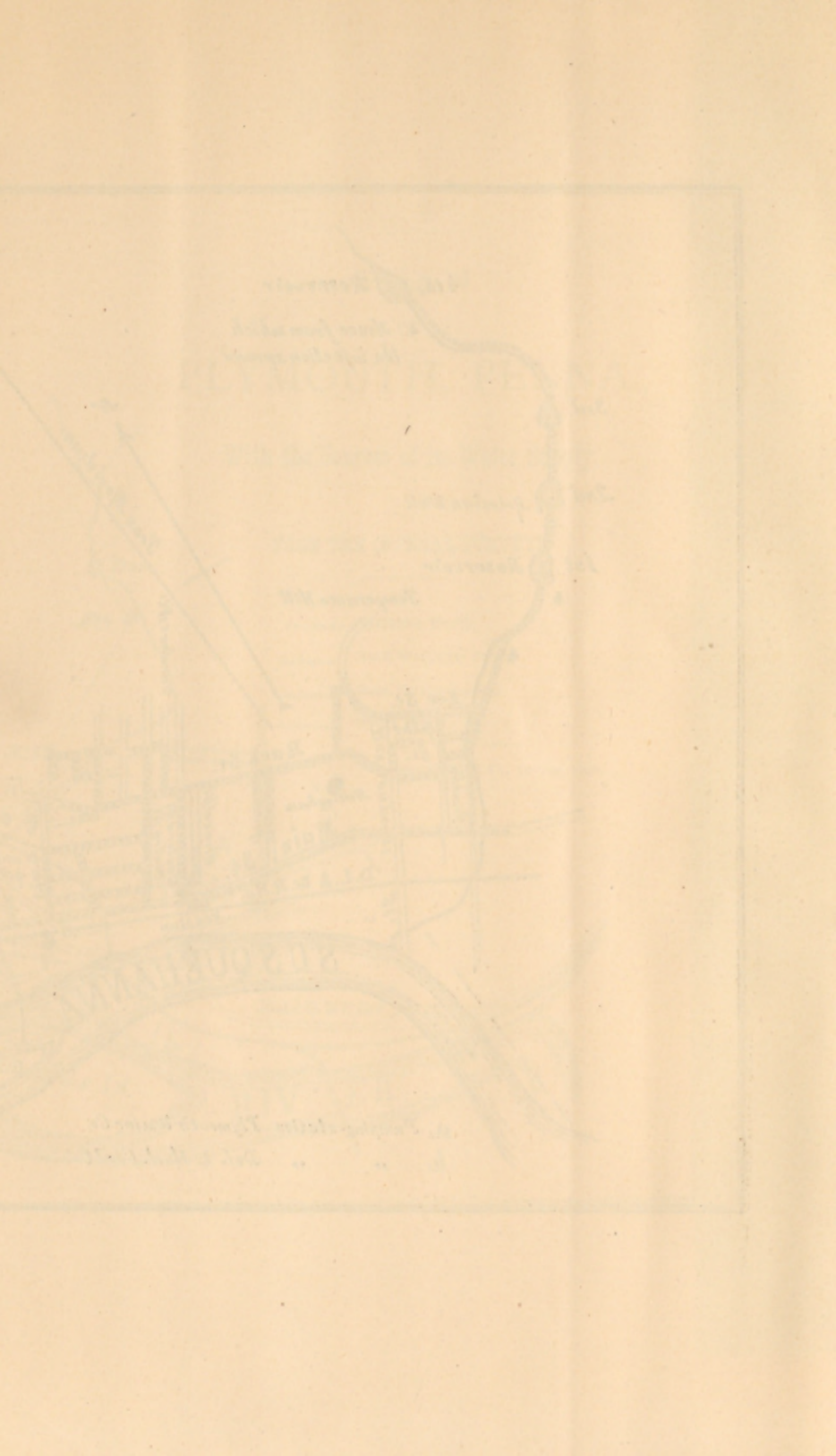
RIVER WATER (ALWAYS).

BROOK WATER.

SCALE, 2300 FT. TO THE INCH.

a. Pumping-station Plymouth Water Co.

b. " " Del. & Hud. Coal Co.



REPORT

UPON THE

EPIDEMIC OF TYPHOID FEVER,

AT PLYMOUTH, PA.

Read by Appointment Before the Luzerne County Medical Society of Wilkes-Barre, Pa., May 21st, 1885, and Before the State Medical Society of Pennsylvania, at Scranton, Pa., May 29th, 1885.

—BY—

Dr. LEWIS H. TAYLOR,

OF WILKES-BARRE, PA.

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THE EPIDEMIC OF TYPHOID FEVER,

AT PLYMOUTH, PA.

GENTLEMEN:

The borough of Plymouth, a mining town of eight or nine thousand inhabitants, situated on the right bank of the Susquehanna river, three miles below the city of Wilkes-Barre, in Pennsylvania, has recently witnessed the outbreak of a most remarkable epidemic of typhoid fever; in fact an epidemic almost unparalleled in the history of this disease, and one that presents, to medical men at least, many points of special interest.

When we study the topography of this region and of the country extending a few miles farther up the stream, with many houses situated on alluvial soil with imperfect drainage; and when we remember the carelessness which seems habitual to many of our fellow-men, we can readily believe that typhoid fever, dysentery, and the like, have there prevailed to a considerable extent during the past two or three years.

Careful inquiry among the gentlemen of our profession, who practice in the region above mentioned, elicits the fact that many cases of typhoid fever were treated by them during the year 1884; chiefly, however, during the summer and autumn months; but at no time, however, in past years, has this disease been so prevalent as to be regarded with alarm either by the physicians themselves or by the people at large.

During April of the present year an epidemic of great virulence broke out, and so sudden was its onset that within comparatively a few days, many hundred persons were

stricken with the dread disease. Its ravages were not confined to any class of people nor to any section of the town, but dwellers in mansion and hovel were alike attacked, the house upon the hillside being not more free from the scourge than that situated in the valley.

The epidemic appeared so suddenly, following upon a few days of warm weather, and the symptons of those first attacked were so severe, that some diversity of opinion as to the true nature of the disease seemed, for a short time, to exist in the minds of the attending physicians.

It was variously declared to be typhoid fever, malarial fever, typho-malarial fever, and typho-malarial-meningitis; but in a very short time its nature was made manifest, and the doubt no longer exsisted that a true epidemic of typhoid fever was hanging over the doomed borough of Plymouth. The first post-mortem examination was secured by Drs. Davis and Beckwith only after urgent solicitation, the people being singularly averse to any such examinations, notwithstanding many had already died. This autopsy was conducted by Dr. E. O. Shakespeare, of Philadelphia, on May 10th, in the presence of several physicians from Wilkes-Barre and Plymouth. Two other examinations were made on the following day by Drs. Shakespeare and French, and in every case the characteristic lesion of Peyer's glands was found.

If doubt as to the diagnosis lingered in the minds of any, it was finally dissipated when these autopsies showed the disease to be genuine typhoid fever.

It spread with great rapidity. From fifty to one hundred new cases appeared daily, and on one particular day, it is said, two hundred new cases were reported. At least one thousand persons in all have been affected.

Various theories as to the cause of this outbreak were put forth; some holding that it was due to the filth of the town, some that it was due to drinking polluted well water, others

polluted river water, others polluted mountain water, and others that it was due to a peculiar condition of nature by no means explainable.

Among these various theories advanced, one of the first was, that it was due to the accumulated filth of the town, which, being acted upon by the warm rays of the April sun, had suddenly become noxious, and the emanations therefrom had caused the disease. This especially suited the "typho-malarial" theorists. But, although Plymouth is not an especially clean town, it is not, on the other hand, more filthy than other neighboring towns where the disease does not prevail, nor was it at this particular time in worse condition than in preceding years.

Again, as the true nature of the epidemic became known, the filth theory fell to the ground, because, although an unclean town is not usually regarded as a healthy town, it is admitted by common consent that filth *per se* does not cause typhoid fever. The emanations therefrom may so prepare the system, or, figuratively speaking, so till the ground, that when the proper seed is sown an abundant harvest may be the result. In this epidemic all classes of people were attacked, the clean as well as the filthy; and all parts of the town affected, the highlands as well as the valley; and, inasmuch as this was the case, thoughtful minds naturally turned to the water supply as furnishing the true cause of the invasion.

Whether typhoid fever may be communicated directly through the air or not is still a mooted question, but it is generally admitted that, in a large majority of cases, at least, the poison is conveyed to the system by means of polluted food and drink taken directly into the stomach.

The inhabitants of Plymouth receive their drinking water either directly from private wells or from hydrants under control of the Plymouth Water Company. Knowing the history of many epidemics of typhoid fever, and knowing

the facility with which wells become contaminated from carelessly located privies, the thought of well-water contamination naturally presented itself to many. That this was not the case was clearly shown by some very interesting facts.

Near the extreme southern end of Plymouth, upon the banks of Coal street creek, a house was found in which hydrant water is used, and in this house two persons were sick with the disease, while in another, in which well water is used, situated but sixty feet distant, all the inmates are, and have been, free from the disease. A little farther to the north of these two houses there are found, on Temperance Hill, eleven families using well water, and no case of typhoid fever has yet appeared in any of these families.

On the upper side of Lee street almost every family using hydrant water is affected, while those living on the lower side of the same street are all supplied with well water, and none of them are sick. Upon Welsh Hill a community of several hundred persons was found supplied exclusively with well water. There were, upon the day of our investigation, but six persons sick on this hill, and these all were persons who had been working in Plymouth in the daytime and were accustomed a part of the time to drink water from the hydrants.

The same relative condition exists in other parts of the town, the investigation of numerous cases showing that persons who used well water in general and are suffering from the disease, are those who had been in the habit of drinking hydrant water while away from their homes, while those who use well water exclusively are nŏt attacked. It is thus shown conclusively, we think, that well water as a factor in the causation of this epidemic must be excluded.

Inasmuch as the disease is found wherever hydrant water is used, and *only* there, the conclusion is irresistible that this was the chief and only cause of this remarkable outbreak.

The hydrants receive their supply from two sources. During the greater part of the year it is from a mountain stream of great purity, which is distributed through the various streets by pipes running from the lower or first of four successive reservoirs, formed by huge dams of masonry across the stream. Occasionally, however, when the water in this stream is quite low, the pipes are supplied with water pumped directly into the mains from the Susquehanna river. This was the case from March 20th at noon to March 26th in the evening of the present year.

Here then are, apparently, two possible sources of contagion, and it is evident that the cause of the epidemic must be traced either to the water pumped from the Susquehanna, or to that supplied by the mountain stream.

Why not the river water? In considering this question we must not forget the exact time the river water was used —March 20th to March 26th—and the relation of this time to the outbreak of the epidemic. From replies to a circular sent to the physicians of Plymouth I find that the outbreak occurred about April 10th to 12th, there being one case reported as early as April 9th. A large increase occurred after April 15th. The gentleman who saw his first case April 9th, saw but thirteen more in the next five days, while another, who saw his first case April 14th, saw seventy-five new cases in the five succeeding days.

The length of the period of incubation in typhoid fever varies, but it is usually stated as being from ten to fourteen days. Dr. Stille states fourteen days. Liebermeister says three weeks; i. e., counting to the time the patient is thoroughly ill with the fever, though he says in many cases the period seems to be but seven days. Wilson, in his treatise on continued fevers, gives the average period as fourteen days, though he cites numerous cases to show that exceptionally it may be as short as five, three, and even two days; while very exceptionally it may be as long as four weeks. He mentions

one particularly interesting epidemic in which a number of persons on a certain day visited a neighboring town, and while there drank from a well polluted with excreta from a typhoid fever patient. Of these, fourteen were attacked who drank from the same well at the same time, and their cases showed a range in the period of incubation from eight to eighteen days.

Dr. Thomas Watson cites the following interesting cases:

"In North Taunton A and B lodged next door to a house in which typhoid fever existed. The two houses had a common privy. Both of these men took the disorder, and, becoming too ill to work, returned to their respective homes in the parish of Morchard, seven miles off. A at once took to bed. Ten days after, his two children were laid up with the same disease, and had it severely. B, a single man, lodged with two aged persons. When at his worst a friend, C, who called, was asked to assist in raising him in bed, and was overpowered by the smell. Ten days after, in another part of the city, C was also down with the fever."

Trossean cites cases to show that the period of incubation is six days. All of the authorities that I have consulted admit that many cases, at least, may appear in ten days from the time of infection, while others may require a much longer time.

But suppose we admit from two to three weeks as a proper *average* period of incubation instead of from ten to fourteen days, as is claimed by many, we should, nevertheless, expect *some* cases to arise in ten days from the time of infection. If, then, it be from drinking Susquehanna water, we should look for some cases of the fever as early as March 30th, or ten days from the time the pumping of river water began; but no such cases appear, nor do they appear within ten days after the pumping ceased, i. e., within ten days of March 26th. Inasmuch as no outbreak occurred previous to April 10th, we would infer that the poison was not taken previous to the last days of March, or the first day of

April; in other words, not until several days after the use of river water ceased.

Whether decomposing sewage in drinking water will produce typhoid fever without the dejecta of a typhoid patient being present, is still an open question. Dr. Downs, reported in the *Lancet* and quoted by Parkes, records six cases of typhoid fever as the result of the overflow of non-typhoid sewage into a well. On the other hand, cases recorded by Allbut and Wohlrab show that contaminated water may be used for a long time without causing typhoid fever; then persons affected with the fever enter the place and their dejecta pass into the water causing an outbreak of typhoid fever. In an admirable article read by Dr. E. G. Janeway before the New York Medical Society, February 18th, 1884, and in the discussion which followed, the prevalence of opinion seems to be that the disease does not arise *de novo*, but is spread only by contamination from previous cases of typhoid.

An extremely strong case is quoted by Ballard:

"Very polluted water had been used for years by the inhabitants of Nunney without causing fever, when a person with typhoid came from a distance to the village, and the excreta from this person were washed into the stream supplying the village. Between June and October, 1872, no less than seventy-six cases occurred out of a population of eight hundred and thirty-two persons. All of those attacked drank of the stream water habitually or occasionally. All who used rain or well water escaped, except one family, who used the water of a well only four or five yards from the brook. The case seems quite clear: first, that the water caused the disease, and secondly, that though the water polluted with excreta had been used for years, no enteric fever appeared until an important case introduced the virus."

He further says:

"Positive evidence of this kind seems conclusive, and we may now safely assume that the presence of typhoid evacuations in the water is necessary; common fecal matter may produce diarrhœa which may be febrile, but for the production of enteric fever the specific agent must be present."

If this argument be true, then river water polluted with the sewage from a large city free from typhoid fever is less dangerous than a smaller amount of water containing the specific poison. All of us, no doubt, have seen cases of this disease which defied all our efforts at discovering their source. I call to mind one special case under my care last autumn. The patient was a lad of fourteen years, in a house remarkable for neatness and cleanliness, nor did the most diligent search reveal any difficulty whatever with the water pipes, or the sewer discharges. No other member of the family, consisting of seven, was affected.

The sewers of Troy all empty into the Hudson, and Albany, which is six miles lower down, derives its water from the river after this sewage has been poured into it. The borough of Nanticoke, situated a few miles below Plymouth, receives all of its hydrant water from the Susquehanna, but at no time has it suffered from a serious outbreak of typhoid fever, notwithstanding the water there used must be contaminated by the sewage from populous towns and cities above. In fact it is proven that Nanticoke had fewer cases of typhoid fever during March and April than in any months of the past year.

It is well-known, however, that typhoid fever is frequently found in Wilkes-Barre, three miles above Plymouth, and might not the Susquehanna become polluted with the specific poison at this place? A careful report from thirty-one physicians in Wilkes-Barre (I failed in my efforts to get reports from two of our physicians) shows that they had under their care between January 1st and April 1st, of the present year, twenty-six typhoid fever cases. Of all this number only two were in houses connected with the sewers, and thus, in all this time there were the excreta of only two typhoid patients poured into the Susquehanna at Wilkes-Barre, and in both of these cases disinfectants were used to neutralize the poison. The flow of the Sus-

quehanna at Wilkes-Barre at low water mark, as taken from the government survey, is nine hundred and thirty cubic feet per second, showing that the dilution of this poison would be, at least, at the rate of six hundred and two millions, six hundred and four thousand gallons per day, and the danger from this source would thus be almost infinitesimal.

But there might be pollution nearer to Plymouth than the cases mentioned above. A medical friend, Dr. C. W. Spayd, in reference to typhoid fever near Plymouth, writes as follows:

"In the summer of 1884 typhoid fever broke out in White Wash Hollow, a small valley that runs from No. 2 to No. 4 Breakers and up the Boston Slope, just below Larksville. In nearly every house from No. 2 to No. 4 Breaker, one or more members were down with it, up to March of this year. The snow melted in that locality during the latter week of March very rapidly, filled the creek with running water, and, as the people were indifferent as to what was done with the excreta, it was carried down said stream into the river below Boston Hill, just above Plymouth, and, in my opinion, the present epidemic sprang from the germs that were carried down into the river from White Wash Hollow."

Now, at first blush, this might seem a point for consideration, but that it could have had no effect whatever in causing this epidemic may be shown from the following statements:

First. This stream joins the Susquehanna at the upper end of Plymouth, and any one taking the trouble to examine it will find that it remains a distinct stream, flowing close to the right bank of the river for a long distance, and does not readily mingle with the general current. The Plymouth Water Company, however, took their supply two hundred and fifty feet from shore.

Second. This is a very small stream and there is but very

little sewage carried by it at any time, as but few houses are situated directly upon its banks.

Third. Whatever this stream might contain, it did not by any possible chance empty any surface water into the Susquehanna in March, previous to the 26th, much less previous to the 20th, for the temperature during the greater part of March was far below the freezing point, thus preventing any thaw of any consequence at this time, and it is positively proven that the stream in question did not at this time carry any sewage into the Susquehanna.

As is well known, March was the coldest month of the past winter. On March 20th the maximum temperature was 20° Fahrenheit; March 21st, 20.1°; March 22d, 20.1°; March 23d, 23.2°; March 24th, 35.6°; March 25th, 34.8°; March 26th, 46.1. So it will be seen that there was no day previous to March 26th that it would be possible for any considerable thaw to take place.*

If further confirmation of the opinion already expressed—that the river water had nothing whatever to do in causing this epidemic—be needed, it may be found in the statement of a few additional facts and in the history of some very interesting cases.

It must be borne in mind that the river water used between March 20th and 26th was not pumped into the reservoir and thence distributed to the town, but was pumped directly into the pipes as already stated, and chiefly devoted to supplying the mines and that part of the town bordering on the river, i. e., Main street, and this part was thus supplied during the whole of the time of pumping, while the valves were all closed in the pipes leading from the Main street pipe to the upper or back part of the town,

* For the above record of temperature I am indebted to the Rev. Dr. Hodge, of Wilkes-Barre, who has charge of the Government meteorological observations at this place.

and this latter part was thus supplied chiefly with water from the reservoirs. But should work at the mines be stopped during any of this time, it would be possible for some of the water pumped from the river to force its way into the bottom of the first reservoir and thus be distributed throughout the town, and it is, without doubt, true that the back streets were thus supplied with some river water for at least two days of this time. It is a notable fact, however, that typhoid fever is not more prevalent, but really less so, in the part supplied with river water, during the whole of this time, than in the parts supplied chiefly with mountain water. But all river water in use, I am informed by the Superintendent, would pass out of the pipes in six hours after the pumping ceased, and it thus could not be used later than March 27th. If, then, the pumping of river water ceased on the evening of March 26th, persons moving to Plymouth after the following day could not possibly drink such water from the hydrants.

The following cases seem to bear directly upon this point:

First. Mrs. J. K. came to Plymouth from Afton, Wisconsin, and arrived March 30th, four days after river water was in use. She was taken sick April 18th, though she had been feeling badly for several days previously. She is now, May 21st, convalescent from a severe attack of typhoid fever.

Second. Mr. M. F., patient of Dr. C. H. Wilson, had been working in Plymouth during the winter, but on April 1st moved his family from Ashley to Plymouth. Himself, and two others of his family who had not been in Plymouth previous to April 1st, are now ill with the fever.

Third. Miss McG., patient of Dr. F. L. McKee, moved to Plymouth from Sugar Notch April 1st, and was taken sick with typhoid fever April 15th, though she had been complaining two or three days previously.

Fourth. Miss H., patient of Dr. Guthrie, went to Plymouth from Wilkes-Barre, March 30th, and remained thirteen days. She returned to Wilkes-Barre on April 12th, feeling badly, and was seriously ill with the disease by April 15th.

Fifth. Miss A. came from New Jersey to Wilkes-Barre in March. She visited Plymouth first on March 25th, remaining only from 10 A. M. to 3 P. M. She went again on March 27th, remained about ten days, was taken sick on April 18th, and has been seriously ill ever since.

Sixth. Mrs. C., Patient of Dr. Guthrie, visited Plymouth first from March 21st to March 24th. Again on March 31st and April 1st. Again from April 17th to April 21st. She was taken sick on April 22d. If she became infected between March 21st and 24th, the period of incubation would be one month, which all admit is highly improbable. If, however, she drank contaminated water on April 1st, the period of incubation in her case would be twenty-one days, or the time claimed by Liebermeister as necessary.

Seventh. R. B., patient of Dr. Spencer, of Dallas, visited Plymouth early in April, about the 5th. He drank water at a barber shop, and also at a livery stable, was taken sick April 15th, and by April 18th had well developed typhoid fever.

Eighth. C. C., patient of Dr. Spencer, visited Plymouth about the last day of March to attend a funeral. He drank considerable water at a hotel, as he was very thirsty. He was ill with typhoid fever and called the doctor on April 22d, though he had been ailing nearly a week.

Ninth. Mr. S. moved his family to Plymouth on March 30th, though he had previously been working there. He was taken ill about April 14th, and died on April 20th. His wife was taken ill on April 18th, and died on May 20th. Frank S. visited this family about April 9th, and later. He, too, was taken sick, and died early in May.

Tenth. Miss L. went to Plymouth with case two, to assist the family for a few days. She remained a week or ten days, returned to her home in Ashley, and was soon after seriously ill with typhoid fever.

Eleventh. Dr. W., resident physician at German Hospital, in Philadelphia, visited Plymouth on April 1st, and drank of the water until April 4th, when he returned to Philadelphia. In a few days after his return he began to feel languid, and this feeling progressed gradually. On April 16th he had a chill, and also on the two following days. April 18th, he took to bed, and was seriously ill with typhoid fever for some weeks. The temperature on the tenth day was 105, and continued from 104 to 105 for several days.

These all drank water in Plymouth, but did not drink river water. No doubt other similar cases exist, but they were not brought to the attention of your essayist.

Is there anything further needed to convince the most skeptical that the Plymouth epidemic was not caused by using river water? If so, here it is. In pursuing our investigation we found at Ridge Row, a community of twenty families living in ten double houses, and at Broadway, a community of forty families in twenty double houses; these two places are in the upper end of Plymouth, and are entirely free from the fever. But all through the fall and winter, and even through the fatal month of March, they were supplied with water by the Delaware and Hudson Company, pumped directly from the deadly (?) Susquehanna, sixty feet from shore and half a mile nearer to Wilkes-Barre sewers than the point at which the pipes of the Plymouth Water Company enter the river. It is proper to state that at Broadway there are two wells, and at Ridge Row one spring and one well, and no doubt many, especially at Ridge Row, used spring water, but the majority of these sixty families used river water exclusively, and continued to do so until April, and, as above stated, no case of the fever has appeared among them.

The people of Plymouth have, at various times, used river water in previous years, without causing outbreaks of typhoid fever. The pumps were used continuously in 1882, from October 27th to January 1st, a period of sixty-five days; again from September 30th, 1883, to February 1st, 1884, one hundred and twenty-four days, and again last Autumn from July 30th to November 24th, a period of one hundred and eighteen days.

No such outbreak followed these pumpings. Gentlemen, can we be made to believe that river water, which is comparatively innoxious to the people of Plymouth at one time last year, for a period of one hundred and eighteen days, when typhoid fever was rife in the city just above, should in six days of the following March cause an epidemic affecting

more than one thousand people, and that at a time when it is proven that it was not contaminated by typhoid fever?

There remains then but one possible cause for this most serious and deplorable epidemic, and that is, contamination of the mountain stream supplying the water company's reservoirs.

A glance at the accompanying map will show the location of this stream and of the several reservoirs. Above the starting point of the water pipes there is but one house situated upon the banks of this stream, and one upon the banks of the fourth reservoir.

In the house between the third and fourth reservoirs, and situated almost immediately upon the stream, there lives a man who is now recovering from the effects of a severe attack of typhoid fever. This patient went to Philadelphia December 24th, 1884, and while there thinks he contracted the disease. Whether he did thus contract the fever in Philadelphia, may, we think, admit of question. But it is nevertheless true that he returned to his home January 2d, 1885, and for many weeks was seriously ill with genuine typhoid fever. Early in March he was convalescent and was out of bed. A relapse occurred about the middle of March, and he was very sick on the 16th. On March 16th and 17th he had hemorrhages of the bowels of so severe a type that on the 18th his life was despaired of, even by his physician. He however rallied, was quite ill for some time, but was convalescent in April, so that his physician discontinued his visits after April 12th.

During the course of his illness the dejecta passed at night, without any attempt at disinfection, were thrown out upon the snow and frozen ground, toward and within a few feet of the edge of the high bank which slopes precipitously down to the stream supplying the town with water. The nurse in charge states explicitly that in emptying the chambers at night she did not stand on the porch to throw

out the contents, but stepped down some distance and threw them toward the creek. If she stepped but a few feet away from the porch she would empty the excreta within twenty-five or thirty feet of the edge of the stream. The dejecta that passed during the day were emptied into a privy a little further back, *the contents of which lie almost upon the surface of the ground.* These dejecta were thrown out from time to time, until the accumulation no doubt equaled the daily dejecta from many such patients. They remained innoxious upon the snow and frozen ground until some time between March 25th and April 1st, when they were washed into the stream and into the third reservoir.

Remember, gentlemen, the maximum temperature on March 26th was 46.5°; March 27th, 56°; March 28th, 43°; March 29th, 37°, increasing rapidly until April 4th, when a temperature of 70° was reached. Remember also that this house does not stand in a ravine nor in a protected spot, but in the midst of an open clearing, which clearing would naturally feel the effect of the sun's rays, and part with the snow and accumulated filth sooner than the more protected regions which also drain into this stream.

March 26th, with a maximum temperature of 46.5°, is the first day upon which any considerable thaw could occur. Upon the evening of this day the Superintendent of the Water Company visited the reservoirs to ascertain whether it would be allowable to discontinue the pumping of river water. He found the first and second reservoirs almost empty, while the third was filling rapidly, the short pipe which allows the water to discharge from the bottom of the third into the stream leading to the second reservoir being tightly frozen. He caused a fire to be built to melt the ice in this pipe, and then stopped the river pumps. This water, with the accumulated typhoid fever poison, was discharged from the bottom of the third reservoir, ran down to the second, on to the first, and was thence dis-

tributed to the town, in all probability between the 28th of March and the 4th or 5th of April.

When might we then expect the first cases from this cause to appear? Regarding the period of incubation as fourteen days, we would look for the first case to appear from April 10th to 15th, with possibly a few exceptional cases somewhat earlier, while the majority would appear somewhat later.

We do not presume to say that all this poison passed out of the third reservoir in five days. No doubt some of it lingered and was operative in diminished strength for some time later, and this but explains more fully the lateness with which some cases of the disease appeared.

It seems to me, gentlemen, that the simple statement of these facts, as I have given them, without any warping or twisting to suit preconceived theories or desirable conclusions, is sufficient to explain fully the cause of this sad scene of desolation, and it points unmistakably to the polluted mountain stream as the chief and only cause of the present epidemic of typhoid fever in Plymouth.

That the mountain stream might have been polluted with fecal matter from a typhoid fever patient was first suggested by Dr. R. Davis, as a possibility, in an article published in the Wilkes-Barre *Record* on April 29th.

The publishing of this article provoked considerable comment, and the water company of Plymouth requested a committee consisting of Dr. J. A. Murphy, Dr. J. L. Miner and myself to make a thorough investigation of its water supply and ascertain, if possible, the cause of the epidemic. This we did on May 6th, examining carefully the whole length of the stream to some distance beyond the fourth reservoir, and we reached unhesitatingly the conclusions already expressed in this paper. The report of this investigation was presented to the Plymouth Water Company

on May 7th, and was subsequently printed in the daily papers of Wilkes-Barre.

A few days later the same ground was gone over by Drs. Shakespeare and French, of Philadelphia, and in a preliminary report to the Philadelphia County Medical Society, on May 13th, they confirm *in toto* the report of the above mentioned committee. Among other remarks they gave the following:

"During the period of pumping from the Susquehanna, the water in that river was lower than it had been at any time for years, and the surface was frozen tight. The City of Wilkes-Barre, containing thirty thousand inhabitants, delivers its sewage directly into the Susquehanna, the mouth of the lower sewer emptying only two miles above the Plymouth pumping station, while the current is very rapid between the two towns. The water is further contaminated by refuse water from five or six mines, as well as by the garbage from the abbatoirs at Wilkes-Barre. Notwithstanding this unusually filthy condition of the Susquehanna water, it is beyond question entirely innocent of causing the epidemic, for the following and other reasons."

They then go on to state certain facts already presented in this paper, and conclude as follows:

"No other conclusion can be arrived at than that this infective poison existed in the mountain water, and originated from the one case of fever in the house on the side of the stream."

From some unaccountable reason this plain statement was misquoted in the morning papers, and it was made to appear that the gentlemen above mentioned had expressed themselves in favor of the river water theory. This called forth a denial from these gentlemen, and at a meeting of the Citizens' Committee in Philadelphia the next day, the following statement from Drs. French and Shakespeare was read:*

* Since writing the above, the report of Drs. Shakespeare and French has been published in full, in pamphlet form, with an appendix containing valuable sanitary rules for the people, in relation to stamping out the epidemic.

"We observe that in some reports of our opinion of the origin and spread of the epidemic at Plymouth, we are quoted as expressing the belief that the Susquehanna water containing the sewage of Wilkes-Barre, caused the disease. This is quite contradicted by the facts which we were able to collect, and is just the opposite to our belief, based upon our investigations. We are of the opinion that the Susquehanna water had nothing to do with the outbreak of the epidemic, but that, on the contrary, those portions of the town which were less supplied with mountain water and more supplied with Susquehanna water, have suffered the least."

A few days later a third thorough investigation was made by Drs. Taylor and Edson, of the New York Health Department, and Chemist Martin, of the Columbia School of Mines. Their report * has not yet been published, but they expressed themselves as decidedly of the opinion that the epidemic was entirely due to the polluted mountain water. They found one or two cases of the disease in families supplied with milk from neighboring families where the disease existed, but as these had also drunk the hydrant water, it was impossible to tell from which scource the infection came.

* An abstract of the New York committe's report appeared in the New York *Tribune* on May 28th. They state the same facts as given in this paper, and reach the same conclusions. They also say: "The Water Company has four storage reservoirs in a ravine, extending to the top of the Shawnee mountain, overlooking the town. These reservoirs have a capacity of about 10,000,000 gallons. They are fed by mountain streams and an artesian well, 1,950 feet in depth. In the extreme cold weather of last winter the people let the water run day and night, to keep the pipes from freezing. All the water stored in the four reservoirs was exhausted on March 20th, the springs in the mountain having dried up. For a week water was pumped from the river, but the people disliked to use it, believing that the river was contaminated with sewage from Wilkes-Barre, three miles above. Water from the mountain reservoirs was used again on March 27th. It is now believed that if the river water had been used a few weeks longer, the great epidemic would not have occurred."

A fourth thorough investigation was made by a committee from the Buffalo Board of Health, Dr. A. H. Briggs being chairman. After a statement of the history of the epidemic, etc., they conclude as follows :

" From the above facts we drew the conclusion that this epidemic owes its origin to the solitary case in the Davis family. The excrement thrown on the slope undoubtedly contaminated the water of the entire brook. It is a notable fact that those using water from springs and from the Susquehanna river, have been largely exempt from the scourge."

In fact, the same conclusions have been reached by everybody who has made any investigation of the matter. The only opposition has come from persons who have not visited the ground, but who have written from the privacy of their offices upon the supposed possible origin of epidemics.

Now, it is not the province of this report to discuss the cause of possible epidemics, or of epidemics of typhoid fever in general, but to state as clearly as may be the cause of the present epidemic in Plymouth.

It is true that polluted well water may cause sickness, but it did not cause this epidemic. It is true that polluted milk may cause sickness, but it did not cause this epidemic. It is true that polluted river water may cause sickness, but it did not cause this epidemic.

I trust I may not be misunderstood in this matter, nor be quoted in any way as favoring the use of river water for drinking purposes, especially of river water contaminated by sewage. The subject is not a pleasant one to contemplate, and it should ever be condemned by us, and ever severely condemned. The constantly increasing amount of sewage poured into the Susquehanna at Wilkes-Barre and neighboring towns will ever render this a dangerous source of supply to the people of Plymouth. But even river water, contaminated with sewage, without the specific

typhoid fever poison, is not so dangerous as reservoir water contaminated by such specific poison. I would say further, that the river water used in Plymouth from March 20th to March 26th, in my opinion, had nothing whatever to do in causing the present epidemic, except, possibly, indirectly, by rendering the system more susceptible to the poison that subsequently followed. Had river water alone been used at this time, there would possibly have been the usual number of isolated cases that any year may show in Plymouth, but there would have been no serious epidemic had it not been for the excreta thus carelessly thrown out upon the ground and later washed into the stream.

That the excreta from one typhoid patient have frequently poisoned the water supply of whole neighborhoods and thus caused such outbreaks, is well known, and we need only refer in corroboration of this to the well known epidemic in New Boston in 1843, reported by Dr. Austin Flint, and to the outbreak at Munich in 1860, and again in 1862; at Caterham and Rod Hill in 1878; and especially to the outbreak (previously mentioned in this essay) at Nunney, in 1872. In considering the possibility of one patient poisoning a thousand in Plymouth, we must bear in mind all the attending circumstances:

1. The accumulation of weeks, equaling the dejecta of many patients.

2. The nearness to the stream.

3. The sudden thaw, pouring the surface water into the empty reservoir.

4. The concentration of the poison in a small amount of water.

5. The short distance to the town; and, finally, the possible previous preparation of the soil for the reception of this seed, which sprang at once into vigorous growth and ripened for an abundant harvest of death.

The condition of affairs in Plymouth but a short time back was sad, and only sad, in all its features, and yet it presented many points of interest to medical men. We had in this epidemic everything presented that was necessary to a complete study of typhoid fever. Here are the regular typical cases, together with the many varieties or seemingly exceptional cases. Here are the three classes so graphically described in Reynolds' System of Medicine.

The FIRST CLASS, with its insidious, gradual approach, moist, tolerably clean tongue, cool, palid skin without eruption, and later presenting the more serious typhoid symptoms, ending too often, when least expected, in death.

The SECOND CLASS, with its more sudden approach, moist but furred tongue, high fever, etc.

The THIRD CLASS, with dry, glazed tongue, intense heat of head, acute delirium, frequent vomiting and purging, painful abdomen, etc. All these have been present.

This epidemic, as already mentioned, has been widespread, and from careful inquiry, I find no occasion to change the statement which I made in the *Medical News* under date of May 9th, that in Plymouth and immediate outskirts there have been rather more than one thousand cases. The death roll thus far has reached nearly one hundred. It must not be supposed that everybody sick in Plymouth is down with typhoid fever. There are, undoubtedly, many ill with other diseases, and, undoubtedly, many ill with fever not distinctly typhoid. The chief danger is passed, but many new cases will probably arise from secondary infection, as gross carelessness has existed among the people in regard to disposing of the dejecta, and even physicians themselves have not exercised that care which the urgency of the case demanded. Especially are the wells upon the side hills liable to contamination from carelessly disposed excreta.

It is one of the most remarkable epidemics in the history of typhoid fever, and teaches us some important lessons at fearful cost. One is, that in any case of typhoid fever, no matter how mild, nor how far removed from the haunts of men, the greatest possible care should be exercised in thoroughly disinfecting the poisonous stools. The origin of all this sorrow and desolation occurred miles away, on the mountain side, far removed from the populous town, and in a solitary house, situated upon the bank of a swift running stream. The attending physician did not know that this stream supplied the reservoirs with drinking water. Here, if in any place, it might seem excusable to take less than ordinary precautions, but the sequel shows that in every case the most rigid attention to detail in destroying these poisonous germs should be enjoined upon nurses and others in charge of typhoid fever patients, while the history of this epidemic will but add another to the list of such histories, which should serve to impress medical men, at least, with the great necessity for perfect cleanliness, a lesson which mankind at large is slow to learn.

Another lesson taught by this history comes more nearly home to us all. The water companies throughout our land should be taught that they must furnish us the water for which we pay from the best source that the country affords. Not only should they avoid the use of river water contaminated by sewage, but they should be compelled to remove from the banks of their streams and reservoirs, not only all probable, but all possible source of pollution.

Shall we, too, wait for a similar sad experience brought to our own doors, or shall we not rather by being forewarned be also forearmed?

In gathering material for this essay I have been especially indebted to my friend, Dr. J. L. Miner, who has been my associate throughout the investigation. Also to Mr. O.

M. Lance, superintendent of the Plymouth Water Company; to Mr. Delbert Barney, student of medicine; and to the physicians of Plymouth and elsewhere who so kindly answered my inquiries and assisted in gathering facts relative to the epidemic; and finally, to my friend, Dr. B. Alex. Randall, of Philadelphia, who has so skillfully arranged the accompanying map in proper shape for publication.