Thesis for M.D.
May 1890.

The water supply of the
town of
Perth,
an epidemic of
Enteric Fever.

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Portland Place
Perth
Cumberland
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The town of Perth is perhaps the most ancient in the kingdom of Scotland. It is traditional, but nearly certain from the remains found, that it existed in the time of the Romans (vide Annals of Perth p. 8).

It was one of the chief towns during early Scotch History and Parliament often met within its walls (vide Tytler I. 45. III 8).

The town was in very early times a strongly fortified place but the fortifications were from time to time destroyed in the various battles and sieges in which Perth had a share, so that when Cromwell took the town it was unfortified & he made a strength of it only by building a citadel outside the town proper. It is not difficult to account for the relative importance of the town. It is situated on the river Tay at the highest point to which the tide rises & the river from this to the sea is navigable by seagoing ships. The town is also so situated as to be the natural centre of a large
agricultural district, many extensive straths & glens converging to the plain in which it lies. The site as distinguished from the situation is not a very excellent one either from the point of view of the soldiers or the hygienist.

Most of the town lies on a flat lowlying surface, almost surrounded by hills or rising ground only a few feet above the level of the river. In ancient times the defects in natural strength were compensated by a deep fosse filled with water from the Town Lade.

This Lade from the River Almond was extant in very early times, it is by some ascribed to the Romans. There is at least good evidence that it existed in the eleventh century (Peacock's Annals of Perth p. 599). It is mentioned too in the story of the siege of the town by Bruce in 1311 (Tyler p. 109 vol 1).

By those particulars the site of the town—or at least the old part of it & the nature of its surrounding—can be best understood. Its situation
is by no means so unhealthy as might be supposed from its low level and the surrounding heights. The soil of sand and gravel and the plentiful supply of flowing water conduce greatly to the speedy removal of all matter injurious to health. Besides, the town is placed just in a break in the hills through which the prevalent East-West winds must pass, so that there is constant renewal of the air.

Perth has been visited by epidemics many times like all old towns, e.g., the plague in 1585 carried off no fewer than 1427 persons out of a population of 7000 (Peacock, pp. 483, 570). Cholera visited the town in 1832 and 147 persons died of it. (Peacock p. 483)

* So low lying is the town that nearly twice in every century, great part of it is inundated—chiefly when the breaking up of ice on the river, a spate on its tributaries, or a high spring tide all coincide. The last inundation was in 1847 when the river rose twenty-one feet (Peacock p. 472).
Perth at last census had a population of 30,000. It is now estimated to be 83,200.

The town has now spread from the level ground on which it once solely occupied to the heights around, numerous streets and terraces are being built at a considerable height above the old town on both sides of the river.

The town is the smallest of the eight large Scotch towns. The occupations of the working population are none of them unhealthy. The chief of them are dyeing, linen manufacture, flour milling. There are many also employed on the various railways and at the large saleyards for cattle and sheep.

The health of the town is not the best of the eight large towns— to judge from the death rates. On page 8, see the death rates for two different periods of five years. In neither has Perth the smallest death rate as it ought to have.

I hope to show that the water supply is to some extent a cause of ill-health.
that it constitutes a grave danger, liable at any unexpected time to cause a large increase in the mortality.

In the first place, the diseases which are most likely to arise from the use of unpure water are more prevalent at Perth than in most other towns.

Note in the following table, (p. 7) that the mortality in Perth in the last five years is proportionately greater from enteric fever than in all the other seven Scotch towns, except Leith. The mortality from diarrhoea & dysentery is greater than in Glasgow, Edinburgh, & Greenock.

The best town for comparison with Perth is Carlisle. The population of Carlisle is little more than that of Perth. It also is situated on a plain beside a river, & the occupation of the working inhabitants are nearly the same.

On page 8 are the proportionate statements of deaths from enteric fever, from diarrhoea & dysentery for these two towns, & although in the register an epidemic enteric fever is mentioned
as occurring in Carlisle in two of the years given, the numbers for that city compare favorably with those for Perth.

The differences between the figures for Perth and other towns is not large, but comparison of other years shows that these three diseases are always prevalent in Perth to a much greater degree than they ought to be if the sanitation of the town were in the best condition, and I hope to be able to prove that this in one very important part the sanitation is as bad as possible.
Table of percentage of deaths from enteric fever to the total deaths in the eight large towns for the last five years:

<table>
<thead>
<tr>
<th>Year</th>
<th>Glasgow</th>
<th>Edinburgh</th>
<th>Dundee</th>
<th>Aberdeen</th>
<th>Greenock</th>
<th>Irvine</th>
<th>Paisley</th>
<th>Perth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1885</td>
<td>85</td>
<td>165</td>
<td>58</td>
<td>64</td>
<td>39</td>
<td>136</td>
<td>76</td>
<td>74</td>
</tr>
<tr>
<td>1886</td>
<td>69</td>
<td>78</td>
<td>46</td>
<td>63</td>
<td>47</td>
<td>141</td>
<td>32</td>
<td>105</td>
</tr>
<tr>
<td>1887</td>
<td>88</td>
<td>78</td>
<td>30</td>
<td>71</td>
<td>47</td>
<td>311</td>
<td>87</td>
<td>68</td>
</tr>
<tr>
<td>1888</td>
<td>63</td>
<td>63</td>
<td>61</td>
<td>60</td>
<td>74</td>
<td>145</td>
<td>111</td>
<td>120</td>
</tr>
<tr>
<td>1889</td>
<td>93</td>
<td>69</td>
<td>64</td>
<td>70</td>
<td>156</td>
<td>140</td>
<td>65</td>
<td>105</td>
</tr>
<tr>
<td>Average</td>
<td>79</td>
<td>70</td>
<td>51</td>
<td>65</td>
<td>76</td>
<td>144</td>
<td>78</td>
<td>94</td>
</tr>
</tbody>
</table>

Percentage of deaths from diarrhoea & dysentery to the total deaths:

<table>
<thead>
<tr>
<th>Year</th>
<th>Glasgow</th>
<th>Edinburgh</th>
<th>Dundee</th>
<th>Aberdeen</th>
<th>Greenock</th>
<th>Irvine</th>
<th>Paisley</th>
<th>Perth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1885</td>
<td>2.59</td>
<td>2.02</td>
<td>2.64</td>
<td>2.67</td>
<td>2.86</td>
<td>2.65</td>
<td>2.27</td>
<td>3.16</td>
</tr>
<tr>
<td>1886</td>
<td>2.09</td>
<td>2.03</td>
<td>4.89</td>
<td>3.69</td>
<td>2.42</td>
<td>4.57</td>
<td>3.09</td>
<td>3.33</td>
</tr>
<tr>
<td>1887</td>
<td>1.89</td>
<td>2.30</td>
<td>4.01</td>
<td>2.32</td>
<td>2.27</td>
<td>3.87</td>
<td>4.53</td>
<td>3.25</td>
</tr>
<tr>
<td>1888</td>
<td>2.05</td>
<td>1.55</td>
<td>3.32</td>
<td>2.63</td>
<td>2.21</td>
<td>2.64</td>
<td>1.54</td>
<td>1.37</td>
</tr>
<tr>
<td>1889</td>
<td>2.66</td>
<td>2.23</td>
<td>3.46</td>
<td>3.34</td>
<td>3.57</td>
<td>4.05</td>
<td>2.60</td>
<td>2.45</td>
</tr>
<tr>
<td>Average</td>
<td>2.61</td>
<td>2.02</td>
<td>3.76</td>
<td>2.93</td>
<td>2.66</td>
<td>3.35</td>
<td>2.80</td>
<td>2.71</td>
</tr>
</tbody>
</table>

The sum of these averages:

<table>
<thead>
<tr>
<th>Glasgow</th>
<th>Edinburgh</th>
<th>Dundee</th>
<th>Aberdeen</th>
<th>Greenock</th>
<th>Irvine</th>
<th>Paisley</th>
<th>Perth</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.40</td>
<td>2.92</td>
<td>4.27</td>
<td>3.58</td>
<td>3.42</td>
<td>5.39</td>
<td>3.58</td>
<td>3.68</td>
</tr>
</tbody>
</table>
Average percentage of deaths to population in the eight Scotch towns for the last five years:

<table>
<thead>
<tr>
<th></th>
<th>Glasgow</th>
<th>Edin</th>
<th>Dund</th>
<th>Abord</th>
<th>Greend</th>
<th>Leith</th>
<th>Paisly</th>
<th>Perth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1886</td>
<td>2.42</td>
<td>1.86</td>
<td>1.92</td>
<td>2.42</td>
<td>1.82</td>
<td>1.71</td>
<td>2.42</td>
<td>1.79</td>
</tr>
</tbody>
</table>

Population in thousands 1889 (estimated):

<table>
<thead>
<tr>
<th></th>
<th>Glasgow</th>
<th>Edin</th>
<th>Dund</th>
<th>Abord</th>
<th>Greend</th>
<th>Leith</th>
<th>Paisly</th>
<th>Perth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>528</td>
<td>266</td>
<td>163</td>
<td>121</td>
<td>78</td>
<td>76</td>
<td>62</td>
<td>32</td>
</tr>
</tbody>
</table>

Percentage of deaths from enteric fever and from diarrhoea, &c., to the total deaths in Perth & Carlisle for the last five years:

<table>
<thead>
<tr>
<th></th>
<th>Perth I</th>
<th>Carlisle I</th>
<th>Perth II</th>
<th>Carlisle II</th>
</tr>
</thead>
<tbody>
<tr>
<td>1886</td>
<td>1.05</td>
<td>1.08</td>
<td>3.33</td>
<td>2.49</td>
</tr>
<tr>
<td>1887</td>
<td>1.68</td>
<td>2.19</td>
<td>3.25</td>
<td>1.98</td>
</tr>
<tr>
<td>1888</td>
<td>1.20</td>
<td>1.88</td>
<td>1.37</td>
<td>2.28</td>
</tr>
<tr>
<td>1889</td>
<td>1.05</td>
<td>1.11</td>
<td>2.45</td>
<td>1.46</td>
</tr>
<tr>
<td>Average</td>
<td>1.09</td>
<td>1.06</td>
<td>2.60</td>
<td>2.05</td>
</tr>
</tbody>
</table>

The sum of these averages, for each town:

| Perth | 3.59 |
| Carlisle | 3.11 |

Average percentage death rate to population in thousands in 1889 (estimated):

<table>
<thead>
<tr>
<th></th>
<th>Perth</th>
<th>Carlisle</th>
<th>Perth</th>
<th>Carlisle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1887</td>
<td>1.79</td>
<td>1.74</td>
<td>3.22</td>
<td>4.41</td>
</tr>
</tbody>
</table>
The Water Supply

Of the town of Perth is very peculiar. The River Tay on the banks of which the town is built - the old town on the right bank, but a considerable modern part on the left bank, called Bridgeend - the river is crossed by two bridges. One of these for road traffic is almost at the upper end of the town, the other for railway and foot traffic almost at the lower end (see the plan affixed). The lower bridge crosses a sandy island which is rather to the left of the middle of the channel. In this island a long trench is dug from this as a natural filter bed the water is pumped by steam power into a reservoir at the town end of the railway bridge to supply the lower part of the town and into a highlying reservoir on one of the hill sides near to supply the more elevated street houses.

This system was established in 1831 on the plan of Dr Anderson, Rector of the Academy. Before this the town water was drawn either directly
from the river or Town Lake or from pumps or wells. At any point in the valley, from the sandy nature of the soil, the slight elevation above the level of the river, a plentiful supply could be got at little depth. But note the drainage arrangements at the time (1831) when this new water supply was obtained.

There were then no main drains. The streets, doubtless, drained directly into the river, but all private houses were drained into cesspools in the sandy soil. When these got silted up the drain pipe was lengthened & a fresh cesspool dug at a little distance from the first, & sometimes in connection with an old house three or four of these old cesspools existed. In the poorer & more crowded parts, of the town the dirty water refuse from the houses were simply emptied into the street channels.

Thus the whole porous soil became infested with filth & the town became “instead of a Fair City just a Sick” in the words of the Sanitary Officer.

It is easy to see that in such circumstances,
a new water supply was procured by no means too soon, for although the river would be comparatively little affected by the old drainage system, the shallow wells in the town would certainly be polluted by infiltration.

At this time (1831) as I have said the river must have been fairly pure, for although there are some small villages on the banks of the Tay & its tributaries above Perth, any contamination would be rendered innocuous in the great body of water by the rapid current. (Perth Hygiene p. 67).

But turn again to the drainage.

In 1858 the evils of the old system of cesspools having become more pronounced through the increase in population & the growth of the town, a new system was planned & carried out. Main sewers were laid down throughout the town. Gradually all the drainage has been connected with these from the whole drainage, public & private, is carried off by them. These main sewers run directly into the river with almost inconceivable folly, they have been planned so that their outlets
are either above or only slightly below the position of the filterbeds for the water supply.

This can be seen at a glance on the accompanying plan of the river.

And the state of matters is even worse than appears at first sight. For be it remembered
the tide rises in the day a little above the higher
bridge, so that although at low tide the sewage
is prevented by the force of the river current from
mixing with the main body of water dispersed
to run alongside the banks outspread of the
filter beds, yet at high tide especially when
the river is low the sewage & river water are
dammed back & mixed together & of necessity
some of the sewage must penetrate to the
filter beds. The folly of such plans
of drainage & water supply is as I have said
almost inconceivable. One would suppose
that a look at the state of the river at high
tide would be enough to convince it in the
eyes of the most interested or prejudiced in its
favour.

It is noticeable from the
plan that there are three discharging outlets
into the river between the two bridges.

That marked G is the town lade which
Conveys a large quantity of water from the River Almond. This is by no means pure for I have often noticed small patches of weeds, vegetable and other house refuse carried down in its current. This extends well out into the river so that the different waters are well mingled before reaching the filter beds lower down.

The outlets B, C, & D are from sewers:
- B from house & street drains on the Bridgeend side,
- C & D from the High Street North Street main sewers respectively.

The liquid from C & D is very filthy being composed of a mixture of sewage & the discharge from the dyeworks for which Perth is so famous. It is of a blue-black colour (though sometimes quite red) & stains the river well out to midstream or farther when the tide is over at its height. From this description it must be plain on consulting the map that the water which finds its way into the filter may easily at all times, except in some states of the river, have a certain amount of sewage mixed with it. To corroborate this plain deduction...
the following analyses give plain proof of the pollution of the water drawn off for the town supply.

**Analysis of Perth Water.**

The samples were taken in both cases at high tide while the river was moderately full a few days after a heavy spate. I from midstream above the higher bridge. II. from middle of right (main) stream opposite the filter beds. III. from a tap in the town.

Results in grains per gallon.

First Analysis Jan 1890 after the water had been kept a month.

<table>
<thead>
<tr>
<th></th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine</td>
<td>.6</td>
<td>.7</td>
</tr>
<tr>
<td>Moisture and Combustion Agents</td>
<td>.3</td>
<td>.2</td>
</tr>
<tr>
<td>Ammonia Free &amp; Saline</td>
<td>.0077</td>
<td>.0008</td>
</tr>
<tr>
<td>&quot; Albumenoid</td>
<td>.0084</td>
<td>.0028</td>
</tr>
</tbody>
</table>

The analysis was done by Wantzlyn & Chapman's method.

Sample II had a distinct brown colour & gave a considerable deposit apparently of vegetable matter. Sample III had much less colour & no deposit to the naked eye.
Second Analysis, April 1890.

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine</td>
<td>.7</td>
<td>.75</td>
<td>.85</td>
</tr>
<tr>
<td>Moist Combustible Oxygen</td>
<td>.21</td>
<td>.294</td>
<td>.196</td>
</tr>
<tr>
<td>Ammonia, Free &amp; Saline</td>
<td>.007</td>
<td>Traces</td>
<td>Traces</td>
</tr>
<tr>
<td>Albumenoid</td>
<td>.008</td>
<td>.009</td>
<td>.005</td>
</tr>
<tr>
<td>Total Solids</td>
<td>3</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Volatile</td>
<td>1.5</td>
<td>2.5</td>
<td>2</td>
</tr>
</tbody>
</table>

In all three cases the solid, blackness on ignition gave a strong organic smell.

Microscopic Examination of Deposit:

Sample I & II gave a large deposit from eighty ounces. This under the microscope showed much vegetable matter, numerous diatoms & ciliated organisms, many bacteria, micrococci, fungalial growths.

Sample II in addition showed hairs, cotton, flaxen fibres, epithelial scales.

These were absent from Sample I.

In Sample III there was no deposit visible to the naked eye but on microscopic examination of the last water in the containing bottle many bacteria & micrococci were seen.

On the addition of one ounce of white sugar to five ounces of each sample the
difference in the result was striking.

The first appearance to the naked eye of growth was in Sample II in 24 hours, then in Sample III after twelve hours, more in 24 hours in Sample I— in each case a slight turbidity at first.

After four days, there was a distinct scum on the surface of Sample III, a slight one on Sample II, none on Sample I.

This scum examined microscopically was found to consist of colonies of bacteria & micrococci.

From these analyses it is evident that the river water becomes polluted somewhere between the point above the town & that opposite the filter beds.

For in Sample II there are more solids, more organic matter, more albuminoid ammonia, more chlorine, than in I. Microscopically examined too, Sample II showed hairs, human & cotton fibres which are not found in I. The growth of organisms in Sample II is much more rapid & prolific.

The analyses show that Sample III
is even more polluted from the sanitary point of view than either of the others.

In comparing III with the others, it must be recollected that the river water at its first (I) contains much vegetable matter. This is shown by the colour, the deposit of vegetable matter, & the large amount of albumenoid ammonia compared with that of chlorine.

(Wanklyn, p. 68)

Much of this vegetable matter must have been removed by the filtration. Sample III has undergone. Yet Sample III contained as much total solids as I, contained also a considerable quantity of organic matter & albumenoid ammonia & above all contained more chlorine.

Then by microscopic examination, micrococci & bacteria were found quite as numerously in Sample III as in the others.

It seems then that the filtering process had removed some of the vegetable matter & the grosser part of the sewage polluting it but as one would expect was by no means able to remove the dissolved organic matter.
nor the whole of the genus. This latter observation is supported by many reports of epidemics elsewhere. First, especially an epidemic of enteric fever at Lancen (Stein’s Portable Water, pp. 12, 15).

The fact that in both these analyses there was an excess of chlorine in III over that in I & II calls for some observation. When these samples were taken, the river was falling after a heavy flood, so that the channel would be at its best, cleaned by the force of the spate from all deposits of sewage, while the current still running strongly would prevent any admixture of the sewage with its waters. The tap water (III) on the other hand would contain water which had passed through the filter some time previously, and would contain former greater pollution. Thus one would expect a much greater degree of pollution in the river when the waters are low and the current feeble or even absent as in the case of a high tide.
The greater amount of chlorine in the tap water (III) cannot have been due to anything in the composition of the soil of the island in which the filter is dug. That soil has been deposited by the river and were there any extra saline matters in it the river water would long ago have dissolved it out.

Nor can the chlorine have come from sea water; for although the tide in its effects reaches as high as the upper bridge, it goes without saying that the sea water never flows so far up the river. And the analysis of the river water, taken as it was at high tide, proves this. The chlorine then must be evidence of greater pollution than is present in the sample (III) taken of the river water.

It is then clear that the tap water contains more or less of the sewage poured into the river in the neighbourhood of the filter beds.

As a corroboration of my analysis given above the following analysis
by the Glasgow City Analyst may be compared with them.

Sample II from the river opposite the filter at high tide. Sample III from the filter well at high water, thus corresponding closely to II & III in the previous tables.

Analysis in June 1882.
Results in grains per gallon.

<table>
<thead>
<tr>
<th></th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine</td>
<td>28</td>
<td>94</td>
</tr>
<tr>
<td>Oxygen required for organisms</td>
<td>21</td>
<td>0.76</td>
</tr>
<tr>
<td>Ammonia, Fresh Saline</td>
<td>0.0033</td>
<td>0.0017</td>
</tr>
<tr>
<td>Albumenoid</td>
<td>0.0095</td>
<td>0.0042</td>
</tr>
<tr>
<td>Mineral Matter</td>
<td>3.15</td>
<td>4.41</td>
</tr>
<tr>
<td>Organic Volatile Matter</td>
<td>1.68</td>
<td>1.12</td>
</tr>
</tbody>
</table>

Dr. Wallace reported that "these waters are perfectly free from animal pollution" but Number II "is inferior in quality to the other & should if possible be excluded from the supply to the city but it is not uneatable one".

This is surely demeaning with faint praise. Observe that Sample II is the only water supply for the city,
yet Dr. Wallace advises it should not be used. It is pardonable to quote here one or two of the remarks made on the reception of this report by the Town Council. They show what such reports mean to the average lay mind.

One gentleman "expressed gratification at its satisfactory nature," another said "it was shown from the analysis that their water was the best in Scotland" & another said "the analysis was the most favorable which had yet been received." And all this although the analyst had advised the disuse of the water.

In excuse of these remarks, it is fair to mention that Dr. Wallace reported the filtered water as "good & safe for all domestic purposes." Surely this conclusion was too hastily arrived at. Dr. Wallace apparently was in ignorance of the source of the different samples he analyzed, since even in this ignorance his results were sufficient to condemn the polluted river.
water, be sure in the full knowledge of the source of the impurity in it would also have condemned the supply filtered from it. He says too that Sample II amongst the others contains no animal pollution, but had he compared it with a sample taken from the bridge above the town, he must have been forced to the conclusion that some of the impurities present were from the sewage entering the river between the two points.

But there is other striking evidence to show that the river water does contain animal impurities.

The water from the filter beds is pumped into a reservoir on the left bank of the river. The pipes between the two lie in the bed of the river. On the 10th April 1880 these pipes were being repaired & the tide rising before the repairs were completed, some temporary stopping was put in. The engines were started & while the reservoir was being filled the stopping fell out, the consequence being that the river water was pumped directly into the reservoir & distributed over the town.
The results were serious indeed. April
the 10th, when this happened, was a Saturday
and the following day there was an epidemic
of diarrhoea raging in the town, so severe
as markedly to affect the attendance at
the churches. To incapacitate more than
one of the clergymen. This epidemic
continued for more than a year though
not with the violence of its first onset —
but so marked that it came to be known
amongst Commercial Travellers visiting
the town as the "Perth Complaint".
Nor was this all though serious, indeed
the diarrhoea was accompanied by
many cases of enteric fever.

**Enteric Fever**
is endemic in Perth. In looking over
the records of the Infirmary since its
foundation in 1836, there is but one
year in which cases of enteric fever
were absent from its wards. In the
earlier records enteric fever is not
mentioned but many cases of *Continued
fever* are mentioned.
The poison of enteric fever is therefore
never absent from the sewage of Perth.
In this case it showed its presence to some effect. Appended is a chart of the cases of enteric fever occurring in Perth in the five years 1879-80, 81-82, 83. The first three years may be taken as showing the number of cases in ordinary times. The set of figures is from the notification book of the Sanitary Officer. They are not to be depended on for showing the total number of cases occurring, for the notification was not compulsory. To check this set there are also entered the numbers admitted to the Infirmary during the same time suffering from enteric fever.
Taking the two together a correct notion is given at any rate of the comparative numbers of cases occurring in different months. The result is sufficiently striking.
There was evidently a sudden severe outbreak of enteric fever in May 1880. In both lists many cases are entered in the beginning of May. These cases did not occur in any special part of the town.
Chart of the number of cases of enteric fever occurring monthly in the town of Perth in the five years 1879-80-81-82-83. Those entered in red ink are taken from the sanitary officer's notification book (there is no compulsory notification). Those entered in black ink are taken from the case books of the Perth Dispensary.
the new street. Villiers Hospital Institution, suffering as well as the poorest & most crowded districts. There were no drains common to any number of the attacked dwelling, nor was any public supply found to be the cause of infection. The use of the water could have been the only common cause of the outbreak, & coming as it did little over three weeks after the accident of the 10th April — just sufficient time for the thorough development of the fever, one is compelled to believe that the pollution of the water & the outbreak of enteric fever were cause & effect.

Such then was the result of drinking this unfiltered river water. Surely there again is sufficient proof of the mixture of sewage with it.

A similar case of drinking river water polluted with typhoid sewage & resulting enteric fever occurred in the neighbourhood of Penrith on a smaller scale.

The sewage of Penrith is carried a mile out of town to a sewage farm, crossing in its course the river Tamont.
an artificial stream - Thacka Beck runs through Penrith & joins the Earnott close to where the River Crosses. In ordinary times this stream contains little house sewage but into it discharge the surface waters from the streets of Penrith, very foul refuse water from tanneries, shipyards.

At times too, the surplus sewage is allowed to run from the sewage farm direct into the Earnott. Thus the state of the Earnott below the junction of Thacka Beck is identical with that of the Tay opposite the filter beds - at all times polluted with the water from Thacka Beck just as the Tay is with that from the Town Lade. At certain times leaving sewage directly mixed with it as at Perth.

Now although the town of Penrith draws its water supply from the Earnott after slight filtering through a sandbank, it has been wise enough to go higher than the point where the town sewage contaminates the water. Enteric fever is not endemic in
Penrith, but only occurs epidemically. One such epidemic only has occurred in my experience which extends over six years. This was in November, December, January, and February, 1888-9. The parallel with the case of Perth is therefore not to be found here.

But some half mile below the junction of Thacka Beck with the river Eden, stands a mill by the side of the river, with a millstream coming from the river. Here during the last six years three families have successively lived. Of the first I know little except that they suffered much from ill-health. The second I attended during their stay of two years and during that time they had much sickness—chiefly diarrhoea, derangement of digestion, sore throats, fevers.

All members of the family suffered at times. At last they removed to a distance but too late for the head of the family, the miller, who died soon after
with symptoms of ulceration of the bowels, probably tubercular. The rest of the family regained health, suffered no more from their former attacks.

The third family occupied the mill for two years and during that time had very frequent attacks of ill-health. At last one child died of some intestinal affection. The family removed into town, from regained strength. Both these families were healthy again before going to the mill again after leaving it, with the loss of one member each. Evidently something in the dwelling or its surroundings was at fault.

The drainage was all outside the house, insufficiently removed to prevent any bad effects. The water supply was from a shallow well close to the river. Branch of the water for household purposes was drawn from the millrace. That the water supply was the cause of the bad health was to be expected from the pollution it had suffered. And proof of its poisonous qualities came later.
Note to page 29.
Since writing this, I am informed that there was another case of enteric fever at this mill in the month of February — too late to be caused by the former case — due to nothing that could be discovered except the insanitary state of the water.
On November 24, 1888, one of the men working at the mill complained of an attack of diarrhoea and sickness. His story was that on the 20th he had been working long in the mill, being very thirsty he had taken a good draught of water from the mill race. He went home that night as usual to his house in Penrith. During the night he was seized with violent diarrhoea and colic.

On the 24th he was still suffering from diarrhoea and had a temperature of 102°. The case turned out to be one of enteric fever lasting over two months with typical temperature, rash,BackColoridge.

There was no case then or afterwards in the yard in which he lived in Penrith. No other case could be traced to the same milk supply which came from the country, where no enteric fever occurred, no bad drainage existed beside his house, and no other cause could be found for the attack of fever than the draught of water from the river.

Now here on a small scale is repeated what happened in Perth. The water supply
for this house is from the river filtered through a natural sandbank. There is a constant recurrence of intestinal affections of these persons presumably to the water - the river being polluted above the source of supply.

Then when enteric fever is present in the town. Its germ occurs in the sewage from it enter the river. There is a case of enteric fever directly traceable to the use of the unfiltered river water.

(For a case of enteric fever arising from one draught of poisoned water see De Mussey, De La Fiere typhoside Obs. XXX)

It is a curious fact that water with a great amount of sewage pollution may be used for a long time without any bad result. (see Blytt's Food, p. 547, Murchison, p. 492). But the danger is there that some time unexpected disease breaks out with great virulence.

To complete the means of comparison between the Baanet of the Tan there is added an analysis
Of the amount water as supplied to
the town of Penwith, i.e. filtered through sand
and also of the water opposite the mill.
The first like the former analyses, done
by myself, the latter done by a friend.
Results in grains per gallon.

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
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<tbody>
<tr>
<td>Chlorine</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Moist Combustion &amp; ref.</td>
<td>.16</td>
<td>.16</td>
</tr>
<tr>
<td>Ammonia, Free &amp; Saline</td>
<td>.0017</td>
<td>.0066</td>
</tr>
<tr>
<td>Albumenoid</td>
<td>.0097</td>
<td>.011</td>
</tr>
<tr>
<td>Total Solids.</td>
<td>3.6</td>
<td>7.5</td>
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</table>

Microscopic examination showed
much silica, some, hairs, epithelial
scales & linen flax fibres, & numerous
bacteria & ciliated organisms, & diatoms,
in the sediment from 380 of II (the
microscopic examination was done
by myself). When I took sample
II the sewage was running directly
from the sewage farm into the river
& there was beyond all doubt a pollution
of the water. The analysis shows
that the amounts of the results are
not largely altered even in this case.
The much larger amount of solids
in December II must have been due to silica party.
To return to the case of Perth—
appended is a table showing the proportion of deaths from enteric fever & the allied diseases—diarrhoea & dysentery, to the total deaths in the eight large Scotch towns during the five years 1879-80-81-82-83.

This shows well the effect of the epidemic in Perth. The percentage of deaths from these three diseases to all deaths, in 1880 when the epidemic broke out, was 12.67 against 5.17 in Glasgow—the next highest. In 1882 when the epidemic in Perth again became severe the percentage was 9.94 against 6.72 in Dundee—the next highest. And it is evident from comparing the numbers for different years in Glasgow & Dundee that 1880 & 1882 were years when the three diseases were prevalent in those towns, respectively.

The average percentage for the five years was 6.79 in Perth against 4.56 in Dundee—the next highest.

And during the five years there were three of the eight towns with a...
Table of percentage of deaths from enteric fever to the total deaths in eight towns, for five consecutive years.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>1879</td>
<td>1.04</td>
<td>1.20</td>
<td>0.60</td>
<td>1.00</td>
<td>1.28</td>
<td>1.57</td>
<td>0.77</td>
<td></td>
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<tr>
<td>1880</td>
<td>2.13</td>
<td>1.10</td>
<td>0.76</td>
<td>1.17</td>
<td>0.69</td>
<td>1.67</td>
<td>0.75</td>
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<tr>
<td>1881</td>
<td>1.37</td>
<td>1.28</td>
<td>0.68</td>
<td>0.38</td>
<td>0.47</td>
<td>0.87</td>
<td>0.87</td>
<td>0.47</td>
</tr>
<tr>
<td>1882</td>
<td>1.37</td>
<td>1.89</td>
<td>0.72</td>
<td>0.60</td>
<td>0.71</td>
<td>1.73</td>
<td>0.60</td>
<td>6.39</td>
</tr>
<tr>
<td>1883</td>
<td>1.22</td>
<td>0.97</td>
<td>0.68</td>
<td>0.78</td>
<td>0.57</td>
<td>1.06</td>
<td>0.65</td>
<td>1.38</td>
</tr>
<tr>
<td>Average</td>
<td>1.43</td>
<td>1.28</td>
<td>0.68</td>
<td>0.78</td>
<td>0.62</td>
<td>1.32</td>
<td>0.95</td>
<td>2.47</td>
</tr>
</tbody>
</table>

Table of percentage of deaths from diarrhoea & dysentery to the total deaths.

<table>
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<tr>
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</thead>
<tbody>
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<td>1879</td>
<td>1.66</td>
<td>2.50</td>
<td>3.43</td>
<td>2.14</td>
<td>1.59</td>
<td>2.49</td>
<td>3.05</td>
<td>2.77</td>
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<tr>
<td>1880</td>
<td>3.04</td>
<td>2.46</td>
<td>4.13</td>
<td>3.40</td>
<td>2.57</td>
<td>2.58</td>
<td>2.99</td>
<td>9.31</td>
</tr>
<tr>
<td>1881</td>
<td>1.68</td>
<td>1.48</td>
<td>2.83</td>
<td>3.00</td>
<td>2.61</td>
<td>2.44</td>
<td>2.68</td>
<td>3.77</td>
</tr>
<tr>
<td>1882</td>
<td>3.11</td>
<td>2.68</td>
<td>6.00</td>
<td>3.30</td>
<td>2.56</td>
<td>2.98</td>
<td>3.92</td>
<td>3.55</td>
</tr>
<tr>
<td>1883</td>
<td>2.66</td>
<td>2.10</td>
<td>3.04</td>
<td>2.77</td>
<td>2.95</td>
<td>2.43</td>
<td>2.10</td>
<td>2.23</td>
</tr>
<tr>
<td>Average</td>
<td>2.42</td>
<td>2.24</td>
<td>3.88</td>
<td>2.92</td>
<td>2.45</td>
<td>2.58</td>
<td>2.94</td>
<td>4.32</td>
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</tbody>
</table>

Table of the sum of these averages.

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</thead>
<tbody>
<tr>
<td></td>
<td>3.85</td>
<td>3.52</td>
<td>4.56</td>
<td>3.70</td>
<td>3.07</td>
<td>3.90</td>
<td>3.86</td>
<td>6.79</td>
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</table>

Table of percentage of deaths to population average for these five years together.

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</thead>
<tbody>
<tr>
<td></td>
<td>2.58</td>
<td>2.01</td>
<td>2.26</td>
<td>1.99</td>
<td>2.34</td>
<td>2.44</td>
<td>2.12</td>
<td>2.17</td>
</tr>
</tbody>
</table>

Population in thousands in 1883 (estimated).

|        | 515 | 235 | 147 | 109 | 71  | 68  | 57  | 30  |

(Taken all from the Registrar General's Reports)
lower death rate than Perth, although the population of Perth is by far the smallest.

The epidemic in Perth lasted off and on for four years and it is very instructive to compare the number of cases occurring monthly with the monthly weather statistics. Compare the following chart with that on page 24. Note that the weather statistics are those of the eight towns together. The Perth numbers would not vary much from these, but where they did vary, they would be lower for Perth, for temperature, as it is the most northerly of the eight towns except Aberdeen.

The usual tendency of an epidemic of enteric fever is to reach its maximum in autumn, decreasing at the approach of cold weather (see Muncie, p. 445). It is evident in this case that the cold has a great effect. Compare, for instance, the cold in November and December 1850
with the cessation of fresh cases of fever, which follows immediately.

Then in 1881 the winter was not nearly so cold as was followed by a comparatively warm spring & a very warm summer & autumn. This caused a very severe fresh outbreak of the epidemic which reached its height in November. November especially December were cold & the epidemic ceased immediately practically.

There seems here no connection between the rainfall & the course of the epidemic.
1879-80 S1 S2 S3
1880-81
1881-82
1882-83

Graph for the four years

1879-80 S1 S2 S3

Shewing the Results of the analysis of the quantities of red earth in the soil of the 12th. (as taken in the

[Handwritten notes on the right side of the page]
from the facts here noted - the undue prevalence of diarrhoea & dysentery,
enteric fever; the fact that enteric fever is endemic in Perth, becoming at
intervals epidemic, it is evident that the sanitation of the town is at fault in
some respect, and from the various analyses & the practical experiment of supplying the unfiltered
river water for a few hours to the town, it is evident that one weak point in the sanitary arrangements
is the polluted water supply.

This pollution increases year by year with the growth of the
town, which compels a gradual increase in the quantity of water used. Therefore in the rapidity of
its filtration, it also produces a gradually increasing amount of sewage to be poured into the
river. That the effect of this polluted water supply is so slight in ordinary years is simply
fortune of the town. As has been
noted the same apparent freedom from bad results for long time, had occurred in numerous instances — even where the water supply has been much more polluted than here. But in such a state of things, there is a constant risk. Every now and then, the germs of disease, finding suitable condition for their growth & multiplication, cause an acute outbreak. The product of disease finding their way through the sewage into the water again — things work in a vicious circle until it is broken by some external agent, such as we notice here.

The consideration of the water supply at Perth is doubly important at present, for it has been found too small for the growing needs of the town, & it is proposed simply to make an extension of the present system, although a plentiful supply could easily be got, pure & beyond all suspicion of animal contamination.
Clinical notes.

The death rate in this epidemic was low. Out of 319 cases in the sanitary officers' book, there were 27 deaths or 8.4 percent. Out of 154 cases in the infirmary there were 11 deaths or 7.1 percent.

This compares favorably with the table of death rates given by Munson (p. 605), of which the average is 17.4%. With most of those given by De Mussey (p. 244) which vary from 22% to 1% percent.

Abortive treatment. In most of the textbooks on the subject it is stated that there is nothing which avail to stop an attack of enteric fever in its course, e.g. Munson says (p. 651) "we cannot cure the disease," and De Mussey (p. 613) says "alors ne fermazzons meme pas atterrir l'evolution" From the very nature of the disease it is difficult to prove its cure, but in the course of this epidemic there were several cases which pointed to the opposite conclusion.

Thus in some eight or ten cases there were all the symptoms of a consummating attack of enteric fever—
the typical temperature, iliac pain, & diarrhoea. Yet after a few days, the fever subsided & the symptoms disappeared. Such cases are mentioned by Murchison p.550. Surely then if an attack of putrid fever may be stopped short in its course by nature it is not being too sanguine to look for true means of cure. In these abortive cases coming under observation here, the patient had been almost without exception put upon a course of treatment by quinine in ten grain doses twice or thrice a day.

And it is probable that this quinine was the cause of the cessation of the symptoms & the cure of the disease. (Abortive treatment by naphthaline is mentioned in the Practitioner for the year 1885 p.297)
Case of Enteric Fever.

Third week Case I

1st 12mn 2nd 12mn 3rd 12mn 4th 12mn 5th 12mn 6th 12mn 7th 12mn 8th 12mn 9th 12mn 10th 12mn 11th 12mn 12th 12mn

Here P = Cold wet pack, G = Quinquina

1st 2nd 3rd 4th 5th

105° 104° 103° 102° 101° 100°

Here P = Pack, SS = Spec. Salicylic.
Third week  Case III

Third week  Case IV

Third week  Case V

\( S_1 = \text{Soda, s. c. XXX, } S_2 = \text{LX.} \)

\( Q = \text{Quin. succ. 8x XXX} \)

\( H = \text{Intestinal hemorrhage.} \)
Antipyretics.

To lower the temperature in all the cases under treatment three things were used — quinine, salicylate of soda, and the cold wet pack. The last was the only one which could be used with confidence.

See the following chart of temperature (p. 41) taken in five different cases at intervals of three hours. In every case the temperature chart begins in the third week of the fever.

Note that in the first case the quinine in fifteen grain doses never reduced the temperature more than one degree except on one occasion on the fifth night — on the first, second, and fourth days, the temperature even rose after the dose of quinine.

The examination of the fourth case shows the same result. Twenty grains of quinine had little or no effect on the temperature, except on one occasion (the third day) when the dose was repeated twice in the twenty-four hours, even then the temperature
fell only one degree below that of the preceding day, rose again immediately.

The second case shows the slight effect of salicylate of soda even in large frequent doses. On the 2nd, 3rd, and 4th day, the temperature even rose after repeated doses. It fell gradually in the last four days, but that would be just the time when the fever would be naturally abating.

The third case shows the result of very large doses of salicylate of soda. On the third day ninety grains (given in two doses) reduced the temperature considerably, but on the first and second days, the effect of the same quantity was small.

The effect of the cold pack is seen in the first and second cases. In the first case it was not so marked but in the second it twice reduced the fever as much as four degrees. But the temperature rose again in a few hours.

Comparison of all the other charts
leads to the same conclusion—that quinine & salicylate of soda even in large doses are quite unreliable for reducing the temperature, while the cold pack can be trusted confidently, but only for a temporary reduction.

Case 7 has been added to show the effect of hemorrhage in the course of an attack. Hemorrhage repeated in twelve hours brought the temperature down five degrees but only rose again above normal for two days. For a short time.

The connection between the administration of salicylate of soda & the onset of hemorrhage deserves attention.

Out of 108 successive cases, there was hemorrhage in eight or 7.4 per cent. Three of these eight died—two of them directly from the hemorrhage. Of the 108 cases, 19 had salicylate of soda, but 11 had from two to eight doses only. Eight had large repeated doses, 4 out of these eight there
were four cases of hemorrhage. Thus there was hemorrhage in 50-70% of the cases, where much salicylate of soda was given, & in only four percent of the others.

Seeing the apparent connection between the administration of this drug & the tendency to hemorrhage in those cases, & also in other diseases (e.g. the epistaxis frequently occurring, & the profuse menstrual flow in patients who are taking large repeated doses of salicylate of soda for acute rheumatism) it seemed advisable to try its effect where it was desirable to produce such hemorrhage. And in two classes of cases, it has been extremely useful. The one set of cases, is those in which the menstrual flow has been suddenly checked by a chill—an accident often followed by grave lasting consequences.

The other is of those in which the sexual discharge ceases suddenly during the premenstrual period, from
Commencing inflammatory change, or otherwise. In both those affections, there is pyrexia. The salicylate of soda acts in two ways — it is an excellent antipyretic, tending to reduce the temperature rapidly, causing at the same time a profuse perspiration. It also aid, the uterine flux, generally reestablishing it before thirty or forty pains, if the drug have been taken.

As examples of these cases, take the following:

A. H., age 22, domestic servant, on Jan 13th was washing clothes, hanging them out to dry in a cold, east wind. Her monthly flux had begun that morning but ceased suddenly after a shivering fit. The flow stopped entirely & she was in great pain every last fretful all that night. When seen next day she had a temperature of 100° & great abdominal pain & tenderness. After trying Hashexamus & Cannabis Indica for two days with
last bath. Hot applications, with no effect, salicylate of soda was given, twenty grains at first, then ten, every three hours. Before these doses had been taken, the menstrual flow recommenced, the temperature fell to normal, and pain ceased.

M.T., age 25, principal, had a tedious but normal labour on 11th December. Next day the temperature was 100°. On the 13th it was 102°, and the uterine discharge stopped. There was great pain across the abdomen. On vaginal examination, the uterus was found moderately contracted. Tempy of the vagina felt & dry. Salicylate of soda was given (ten grains every three hours). The vagina was well sprinced twice a day with crude fluid in water. In twelve hours the temperature fell to 99°, and the uterine discharge recommenced, and the pain almost ceased.

No alarming symptoms occurred.
although the temperature remained a little high towards evening (never above a hundred degrees) for three weeks. (The cause of this perpetual pyrexia was found to be seepage of foul liquids through the house wall from a byre next to it).

The connection between the administration of salicylate of soda & a tendency to hemorrhage has been pointed out in Guy's Hospital Reports for the year 1887, p. 125 by Dr. Shaw.

In connection with this epidemic at Perth a branch outbreak in one of the neighbouring villages is worth recording. A case of enteric fever in the convalescent stage was imported into the village of Drumming in 1882 (I have been unable to obtain exact dates). The mother of the patient kept cows & sold milk in the village, & the byre being close to the house there was frequent communication between the two, slops t
refuse being emptied into the byre, of the milk being kept in part of the house. The patient had a relapse accompanied by much diarrhoea, of the excreta were emptied as before, in the byre. The mother of the patient attended to him in his illness, and at the same time milked the cows and sold the milk, personally. The result was 30 cases of fever in the village, which were all traced to the same source. Nearly all the attacked were supplied with milk from this byre, and two of the worst cases were in boys who had been in the habit of playing about the byre. Most of the cases were very severe. There were 5 or 6 deaths.
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