

**THE BACTERIOLOGICAL TEST FOR DRINKING WATER.**

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THE following tests were made in May, June and July of this year of the water supplied to the Town and Central Jail of Bhagalpore from the Municipal Water-works.

The test used was that described by Mr. Hankin, of Agra, in his little pamphlet on this subject.

Water from hydrant in jail hospital=8 to 18 m. per c.c.

This is result of *repeated* tests done at various intervals during three months.

Water from hydrant in jail kitchen and in various enclosures inside jail =10 to 20 m. per c.c.  
 Water from public hydrants in various parts of town ... =10 to 22 m. per c.c.

All these are very good results.

The following results are from examination of other (not filtered) waters.

1. An old jail (disused) well = 70 m. per c.c.
2. An open underground tank in jail = 700 m. per c.c.
3. A tap connected with underground tank (2) ... = 300 m. per c.c.

Water from well in warders' lines (seldom used) ... = 120 m. per c.c.

Water from well in Superintendent's garden (constantly used) = 40 m. per c.c.

Water from Police lines = over 1,000 m. per c.c.

Water from a well in Club = 60 m. per c.c.

Any water showing less than 100 microbes per cubic cent. is considered fit for drinking purposes.

The above results of the examination of the filtered water from the Water-works show that the Town and Jail are supplied with a water of high excellence. It compares favourably with the water supplied to such large towns as Agra (15 m. per c.c.) Lucknow (50 m. per c.c.) and Allahabad (150 m. per c.c.) as given in Mr. Hankin's pamphlet.

The agar-agar tubes necessary for these tests are obtainable at small cost from the Laboratory, Agra. The method is simple. It seems admirably adapted as a *test of the efficacy of the filtration* of drinking water in our jails.

**THE NATURAL HISTORY OF HARDWAR FAIR CHOLERA OUTBREAKS.**

By SURGEON-CAPT. H. HERBERT, F.R.C.S.

BEFORE 1892 observation had definitely associated the outbreak of cholera at Hardwar with but one condition—the overcrowding at Kumbh fairs. The only two epidemics of the thirty-four, years 1858—91,<sup>1</sup> had fallen on two of the three Kumbh years of that period, and these were the only two occasions on which the crush was especially remarkable.<sup>2</sup> The estimated attendance of pilgrims in 1867 was 1,250,000; in 1879, 500,000 or 600,000.<sup>3</sup> At

<sup>1</sup> Epidemics spread from the Fairs of 1857 and of 1892.

<sup>2</sup> Figures for the Adh Kumbh Fairs of 1861 and 1873 are not available; they may safely be taken as very much less than at the two Kumbh Mélas mentioned.

<sup>3</sup> 500,000, Govt. of India Sanitary Report for 1892, p. 139; 600,000, ditto ditto ditto for 1879, p. 124.

the third Kumbh Mêla, 1891, the number of pilgrims, 269,345, was scarcely larger than at the Adh Kumbh of 1885, where it was 262,621. There can be little doubt that the holy water drunk at and carried away from these gatherings constitutes the only possible means of such immediate and general spread of the cholera poison as was seen in 1867;<sup>1</sup> for example, that is to say, the excessive crowding of bathers at the two greater Kumbh Mélas must be regarded as having in some way helped in rendering the water of the sacred pool or of the Bhim Ghora tank, or of both, an efficient means of cholera diffusion. Obviously another factor, reduction in quantity of the sacred water, may, as far as the fouling of the water is concerned, have the same result as increase in the number of bathers. This is what happened in the big cholera year 1892. It was one of the driest seasons on record in Northern India.<sup>2</sup> “In the sub-montane tracts many of the streams were dried up, and the water-level in the tanks and wells was much lower than usual.”

Volume of the Ganges at Hardwar in cb. ft. per second at the time of the principal annual fair.

Year.	Volume.
1881	8,000
1882	7,000
1883	7,000
1884	7,000
1885	10,000
1886	12,000
1887	6,000
1888	7,000
1889	12,000
1890	5,000
1891	9,000
1892	5,000
1893	11,003
1894	11,000

The table<sup>3</sup> here introduced shews that the river was lower in 1892 than in any other of the available series of years;<sup>4</sup> and the deficit at the sacred bathing ghât was in this year rendered extreme by change in the channel of the river. Though only 70,000<sup>5</sup> people had assembled, yet “it<sup>6</sup> was impossible, however, to keep the water in the bathing pool so fresh as on the former occasion (1891 Kumbh Mêla, 269,000 pilgrims), on account of the smaller volume of water in the river, and the direct obstruction to its flow in the sacred pool by

<sup>1</sup> “The simultaneous outburst of cholera on the evening of the 12th April in every section of the Hardwar encampment is a phenomenon of great interest..... we find a great multitude which on the 11th April was so little tainted with cholera as to be believed to be quite free from it, thoroughly contaminated in all its parts on the 12th.” Sanitary Administration Report for the Punjab for 1867.

<sup>2</sup> Government of India Sanitary Report for 1892, p. 141.  
<sup>3</sup> This table was very kindly supplied by Mr. Bhoridon, Under-Secretary to Government, Irrigation Department, N.-W.P. and Oudh. He states that the calculations are only very roughly approximate; the volumes given are too low for years of high discharge, *i.e.*, whenever 7,000 cb. ft. per second was exceeded. The table includes all the available years.

<sup>4</sup> The variation in volume of the river is quite small compared with the variation in number of pilgrims in different years. But it must be borne in mind that the effect of a small change in the level of a river is much exaggerated in its shallower portions.

<sup>5</sup> Surgeon-Colonel Huteson, late Sanitary Commissioner to the N.-W. P. and Oudh, tells me that this number is about half of the average accumulation actually present at the height of an ordinary annual fair.

<sup>6</sup> Government of India Sanitary Report for 1892, p. 140.



recently formed obstacles and foreshores." "The section of the river channel varies considerably from year to year under the action of the annual floods."<sup>1</sup> Unfortunately this introduces such an element of uncertainty that although the sacred pool was fouler in 1892 than at the Kumbh Mēla of 1891,<sup>2</sup> we cannot be perfectly certain that it was fouler than in other years, such as might have been characterised by only ordinary accumulation of pilgrims and only moderate drought. The evidence is suggestive only. Though it is possible, it is far from proved that the want of water in 1892 was sufficient to raise the foulness of the pool (and tank ?<sup>3</sup>) to a level comparable with that of 1867 and 1879, and above that of all intervening years. Of the other cholera years 1879 was characterised by moderate drought;<sup>4</sup> and the great Mēla of 1867 fell on a season at least as dry as ordinary.<sup>5</sup> The exemption from cholera attack of the last Kumbh Mēla, 1891, was ascribed<sup>6</sup> to the very elaborate sanitary arrangements for the first time in force; but the evidence is very strong that it was due rather to a severe and prolonged winter season. The complete inefficiency of the sanitary arrangements was well shewn by the cholera outbreak in the following year.<sup>7</sup> There were no extraordinary sanitary precautions in 1885, when the number of pilgrims was almost the same as in 1891, yet cholera did not break out. The winter was severe,<sup>8</sup> as in 1891, and the river consequently high (see table). And there have been other Kumbh and Adh Kumbh years, e.g., 1855, 1861, 1873 with neither special precautions nor cholera. It is now fairly well recognised that the essential sanitary requirement for the prevention of cholera spread here is a very free supply of fresh water, especially at the most

crowded Mēlas, in very dry years, and when the disease is unusually prevalent elsewhere in India.

There was, however, another climatic feature which almost certainly helped in the development of the cholera of 1892. It was not only one of the driest, it was one of the hottest seasons on record.<sup>1</sup> It is significant that cholera broke out on the 22nd March, and that the period 21st—27th was the hottest portion of the hottest March on record.<sup>2</sup> Yet this does not mean very much after all, for the fairs have commonly lasted till the 12th April, on which date the air temperature in other years must often have been as high as on the 22nd March of 1892. On the other hand, it is readily conceivable that the unusually powerful heat rays may have worked to great advantage on the slow and shallow current of the sacred pool in 1892. In one of the other cholera years, 1867, the weather appears to have been cooler than ordinary at the time of the outbreak (April). But in 1879 the mean air temperature at Roorkee for the month of April was 3° above the average;<sup>3</sup> besides 1892 there have been only two Aprils (1875 and 1880) at all hotter than this. On the whole, the temperature factor in the origin of the Hardwar cholera outbreaks appears to be of decidedly secondary importance to those affecting the cleanliness of the water.

I have left till last an important consideration—that of the varying prevalence of cholera at the time of the fair among the general population of India, whence the pilgrims are drawn. The cholera mortality of March 1892 was the highest on record for that month;<sup>4</sup> it was specially high in Bengal. For 1867 the records are incomplete, but it is known that the disease was widely diffused in the country about Hardwar for months before the great Mēla.<sup>5</sup> In the early part of 1879 cholera mortality was distinctly less than ordinary.<sup>6</sup> It is noteworthy that the spread from Hardwar in this year was very much milder than in the other two epidemic years. Excessive general prevalence at the

<sup>1</sup> Mr. Bhordon.

<sup>2</sup> In 1891 the river was full, probably more so than is indicated in the table. "The cold weather was characterised ..... by excessive snowfall in the Himalayas." (India Weather Review, Annual Summary, 1891, p. 476.) "The (1890-91) cold weather rainfall the heaviest on record in many parts of Upper India." (India Weather Review, Annual Summary, 1892, p. 529.)

<sup>3</sup> The construction of a syphon bringing fresh water to the Bhim Ghora tank in 1891 renders its condition in 1892 not readily comparable with that of earlier years.

<sup>4</sup> "The cold weather of 1878-79 was remarkably free from storms in Northern India, and the rainfall of the period was hence considerably below the normal." Indian Meteorological Memoirs, Vol. IV, Part VIII, p. 580.

<sup>5</sup> The total rainfall at the nearest meteorological station, Roorkee, 17 miles away, of the first four months of 1867, was practically normal in amount, viz., 4.05 inches; on the hills it was below normal for this period judging from the Naini Tal record, 11.80 inches (average over 17 inches).

<sup>6</sup> *British Medical Journal*, 1894, Vol. I, p. 363.

<sup>7</sup> "The sanitary arrangements at the Fair (1892) were those which proved so successful in 1891; it was impossible, however, to keep the water in the bathing pool so fresh ....." Government of India Sanitary Report for 1892, p. 140.

<sup>8</sup> "The cold weather of 1885 was ..... unusually severe." Indian Meteorological Memoirs, Vol. IV, Part VIII, p. 661.

<sup>1</sup> "Higher day temperatures were noted in March 1892 over the whole of the interior of India than have been observed during the previous 25 years, and the month is hence the hottest March on record."—*Gazette of India*, Monthly Weather Review, March 1892, p. 82. The highest temperature registered at Roorkee was 102.2°, just one degree higher than the highest recorded in March of any other year.

<sup>2</sup> I know of no evidence to shew that heat in India, however excessive, is ever in itself other than stimulant to cholera development.

<sup>3</sup> Monthly mean air temperatures have been recorded at Roorkee since 1866. The variations from average of the three cholera years are:—1867, March (about) +0.6°, April (about) -2.2°; 1879, March -1.1°, April + 3°; 1892, March + 1.7°, April + 5.1°.

<sup>4</sup> The total cholera mortality of British India in March 1892 was 46,089; the next highest record being in 1891, viz., 33,936; the average for 15 years, 1879—93, being 18,066. Out of the total 46,089 deaths 31,235 happened in Bengal.

<sup>5</sup> See Bellew's History of Cholera in India, p. 425.

<sup>6</sup> Mortality for March 11,800; for April 29,324 (average of 15 years, 1879—93, being 36,980).



time of the great Fair must mean an increased introduction, or at least a greater certainty of introduction,<sup>1</sup> of the virus into the sacred water at Hardwar. The same thing is brought about also by the increase in the proportion of bathers, absolute or relative, which has been already discussed. And the question arises whether this may not explain in some measure the origin of epidemics here. But if so, it must be in quite a small measure. For nothing but the local reproduction of the organism will suffice to explain its wonderfully rapid general diffusion here. And in the laboratory the growth of a microbe depends much more on the character of the culture medium and on the original quality of the organism than on the quantity sown. Excessive prevalence elsewhere means not only increased chances of planting the microbe at Hardwar,—it means the sowing of an unusually active organism, one more likely to thrive and multiply. In this way it may increase the tendency to outbreak at Hardwar, while the effect of excessive crowding of bathers may also be explained in another way. The greater fouling of the water may render it an exceptionally favourable culture material.<sup>2</sup> There is substantial evidence<sup>3</sup> that cholera mortality in India increases with the shrinkage of tanks and other surface water-supplies; and the water of the tanks as it runs low has the same fouling influences at work in minor degree (the stirring up of the mud from the bottom and the direct pollution by the washing of clothes and bathing of the people) seen superlatively at the great Fairs, and the suitability of liquid mud for cholera growth is possibly seen also in the enormous mortality attained in Berar when the great thirst of the black cotton soil is appeased by heavy rains, and when the whole country is “converted into a deep tenacious mud.” The vast importance of the culture material at Hardwar is seen in the fact that the cholera which spreads from the Fairs is not that which is carried to them. Developing under special conditions in a place where the disease naturally has but a feeble existence,<sup>4</sup> the virus acquires powers of resistance well in

advance of those possessed by ordinary Indian cholera. The new growth spreads rapidly and certainly over country where cholera is comparatively seldom seen,<sup>1</sup> and is credited with having been the origin of a European pandemic.<sup>2</sup> The influence of the condition of the culture medium is seen also in the fact that cholera may often be carried to the Fairs and fail to spread there.<sup>3</sup> That the spread depends on the quality of the specialised local product rather than on its quantity is suggested also by the observation that the result in 1892 from the dispersal of 70,000 pilgrims was at least similar in magnitude<sup>4</sup> to that in 1867 from the scattering of probably a million people;<sup>5</sup> and Surgeon-General Cunningham in his report<sup>6</sup> on the epidemic of 1879 notes that there was “no relation between the number of pilgrims and the extent of the disease in different districts.”

To sum up, there is substantial evidence to support the following suggestions:—

(1) The fouling of the sacred water by exceptionally large proportion of bathers to the quantity of water available may render it a very favourable medium for cholera development and so determine the origin of far-reaching epidemics; while (2) the growth of the organism at Hardwar may be assisted by unusually hot weather; (3) virulent cholera elsewhere in India being effective rather in the character than in the quantity of the virus carried to Hardwar.

#### UNHEALTHY TRACTS IN BENGAL.\*

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WITH the exception, perhaps, of the tract of country lying at the base of the Himalaya Mountains known as the Terai, or the special region of malaria, the most unhealthy part of Bengal is the triangular piece of country which lies in the hollow, which is bounded by the high banks of the Rivers Ganges and Madhimati on the north and east, the elevated laterite soil districts of the Sonthal Parganas, Birbhum, Bankura and

<sup>1</sup> The great Fair occurs near the height of the Bengal cholera season, and when the mortality is rapidly on the increase in other directions; so that seldom can the disease fail entirely to be carried to these gatherings.

<sup>2</sup> The bathing pool at the Kumbh Mela is thus described:—“As the bathing went on the clear stream became a muddy one, and the water collected from any part of it smelt in a few hours offensively, and the micro-organisms developed from it were legion.”—*British Medical Journal*, 1894, Vol. I, p. 361.

<sup>3</sup> Of the pool in 1867 it is said: “The water within this space was, during the whole time, thick and dirty, partly from the ashes of the dead brought by surviving relatives to be deposited in the waters of the river-god, and partly from the washing of the clothes and bodies of the bathers.”—Government of India Sanitary Report for 1867.

<sup>4</sup> *Indian Medical Gazette*, 1894, p. 329, *et sequitur*.

<sup>5</sup> The average annual cholera mortality of 27 years in the Saharanpur district, in which Hardwar is situate, is only 0.25 per thousand.

<sup>1</sup> Each of the three epidemics spread rapidly over the Punjab (including its most immune tracts), Sind and Cashmere.

<sup>2</sup> Macnamara in Davidson's *Hygiene and Disease of Warm Climates*.

<sup>3</sup> Isolated cases of cholera are not uncommon at the Fairs; the vibrio was detected in the water of the sacred pool in 1891, and in 1872 there was a localised outbreak confined to a single band of pilgrims, who left their mark on the places they passed through.

<sup>4</sup> The mortality figures of the two years are not strictly comparable owing to the imperfect registration of the earlier year.

<sup>5</sup> The estimate of the number present on the great bathing day, made at the time, is nearly as large as that of the total attendance, of the whole period of the Fair (see Bell's *History of Cholera in India*, p. 518).

<sup>6</sup> Government of India Sanitary Report for 1879, p. 118.

\* Read at the Indian Medical Congress, December 1894.