

"lowering" action will be observed. With regard to the temporary nature of their effects, I think error has occurred from observers not taking into account the fact, that when given with judgment on a rising temperature the mere fact that they break and check that rise is a testimony to their efficacy. Granted that after an interval the temperature again begins to rise, it is at least a fair conjecture that it would have risen higher if uninterfered with. I would be the last to deny the efficacy of cold externally applied in reducing pyrexia, but with a large number of cases and comparatively imperfectly trained attendants these methods are apt to lead to a disturbance and excitement of the patients hardly compensated for by the subsequent reduction of the temperature, it is under such circumstances that the advantages of the anti-febrin class declare themselves.

### FLIES AND CHOLERA DIFFUSION.

BY SURGEON-MAJOR R. MACRAE, M.B., I.M.S.,  
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To scientists of the present day, and particularly bacteriologists, nothing is sacred, and they have attacked one by one many of our cherished privileges. It has been suggested that love-making of the future must be conducted on sanitary principles, and a Russian scientist has, it appears, recently denounced hand-shaking as being a most pernicious practice.

I do not propose to deal with anything so sensational. I merely wish to bring an indictment against the 'common fly,' and charge it with being a most active agent in the spread of disease, confining my remarks on the present occasion to its agency in the diffusion of cholera. I think I shall succeed in shewing that the charge is proven, and that,—it must be acknowledged,—in a country such as this, where we have the disease always with us, and where flies at all seasons abound, is a most serious matter, and requires the earnest attention of all those engaged in combating the spread of disease.

If I shall succeed in convincing any of your readers, I trust such of them as have opportunity,—and, unfortunately, the opportunities only too frequently occur,—will make their own observations, and either confirm or disprove the experiment I am about to relate. There is no insuperable difficulty attached to it, and anyone who does not possess the requisite apparatus can, I am confident, have any preparations examined at any of the Bacteriological Laboratories in Calcutta or elsewhere in India.

I have no doubt that on many previous occasions flies have been denounced as possible agents in the spread of cholera; there are but few things in heaven and earth which have not 'done duty' as causative agents since the disease came to be studied. I have for years suspected them my-

self. I have no means at present of referring to the literature on the subject; but what I wish to urge is that, instead of being merely looked upon in the light of hypothetical agents, they should be considered as one of the most important agencies in the diffusion of the disease.

To elucidate my position it will be necessary for me to give a brief history of an epidemic of cholera which occurred in the Gaya Jail during the month of July. A block plan of the jail is attached to facilitate explanation. It has a superficial area of 204,480 square feet and is surrounded by a boundary wall 15 feet high.

From a sanitary point of view the jail is well situated, and its surroundings are good. Its proximity to a low range of hills which are covered with boulders, and in the hot season totally destitute of vegetation, makes the heat more than usually oppressive.

The main gate of the jail is in the middle of the eastern wall, and the general arrangement of the buildings can be seen on the plan. The cook-room occupies the centre of the enclosure, and the other buildings and yards radiate round it. Commencing on the south side there is first:

*Yard and Barrack No. I for B. Class prisoners.*—This barrack is three-storied, the second and third floors being divided into four sleeping wards with accommodation for 160 prisoners. The first floor is divided into two worksheds.

*Yard No. II*—Contains the *hajut* ward with accommodation for 22 prisoners.

*Yard No. III*—Contains the female ward with accommodation for 16 prisoners. The *hajut* and female wards are end to end and are one-storied buildings.

*Yard No. IV*—Contains a three-storied barrack with four sleeping wards and two worksheds and can accommodate 66 men.

*Yard No. V*—Contains the hospital, a double-storied building, its upper floor consisting of one ward with accommodation for 21 men, the lower floor has four small rooms; at each end two small wards to accommodate 12 men, and between a small dispensary and a small room for Convict Warders.

*Yard No. VI*—Is a *fac-simile* of No. IV with the same accommodation. Its lower floor is used as the jail dairy.

*Yard No. VII* has 16 solitary cells.

*Yard No. VIII*, at the north end of No. VII, has two rooms known as the European cells.

*Yard No. IX.* The A Class Barrack is similar in every respect to No. I, but can only accommodate 153 men as half of a ward has 14 cubicles.

Each yard has its own latrine arrangements, its bathing and feeding platforms and separate boundary enclosure.

The population of the jail on the night on which the outbreak took place was 422. Many of the prisoners were from other districts sent here with a view to benefiting their health.

Their distribution was as follows:—

| No. 1           | Barrack | 140 prisoners. |
|-----------------|---------|----------------|
| " 2             | "       | 22 "           |
| " 3             | "       | 7 "            |
| " 4             | "       | 33 "           |
| " 5             | "       | 33 "           |
| " 6             | "       | 63 "           |
| " 7             | "       | 16 "           |
| " 8             | "       | nil "          |
| " 9             | "       | 102 "          |
| Convict Warders | "       | 5 "            |
| Civil prisoner  | "       | 1 "            |

In the beginning of July the jail was in a normal condition, and considering the class of prisoners there was very little sickness. About 8 o'clock on the morning of the 8th of July an under-trial prisoner named Sukra Goala was admitted in company with a woman passing as his wife. Both these people had been arrested by the police in a village of the neighbouring district of Hazaribagh, and marched through the Gaya District to Gaya. At that time cholera was very prevalent all over the Gaya District. The woman was sent to the female ward of the jail where she remained totally unaffected. The man passed the day of the 8th in the jail *hajut*; but at lock-up time was removed with all other *hajut* prisoners to a 2nd floor ward of Barrack No. 9, as the *hajut* ward could not accommodate the number of *hajut* prisoners present on that date.

It appears that he became ill some time during the night—it is said 4 A.M. The convict overseer in charge did not report the fact, and on opening the jail the prisoner, with others, was again removed to the *hajut* (under-trial) ward. Here he became very ill, and when the Hospital Assistant was sent for he found him collapsed.

The prisoner was temporarily removed to a cell, and on my arrival at the jail was sent to a cholera hut in the outer garden of the jail.

It is important to consider the leading facts in the history of this case, as I have no doubt whatever that through him cholera poison was introduced into the jail.

We have seen the arrival of a prisoner, after an exhausting journey through an infected district into a previously healthy jail. We find this prisoner is attacked by cholera from 16 to 18 hours after admission, and that, owing to exigencies of space and the jail officials being unsuspecting and having been taken by surprise, he is allowed an opportunity of polluting three different portions of the jail. When I say polluting, I mean that it is undoubted that he passed excreta in the *hajut* ward and its enclosure, the ward of Barrack No. 9, and the cell to which he was sent.

Now, jail standing orders with regard to disposal of infective excreta are very efficient if strictly observed. But in this particular instance, it must be remembered, that some time elapsed before the discovery was made that the excreta were infective. The case occurred at night, and the jail subordinates did not at first

realise its gravity. Further, suspicious stools are not destroyed until examined by the Hospital Assistant when they are thrown into an incinerator. But the point I wish to lay stress upon is that, although sufficient care was taken to prevent either water, food, or milk, becoming contaminated, opportunities had occurred allowing some of the swarm of jail flies to find access to the poison.

In investigating the diffusion of cholera during epidemics, the subject always bristles with difficulties. It is notorious that it is diffused in such a capricious way as to bear an appearance of mystery. One cannot trace it from case to case like a pedigree in a family tree. There is the fact among others that, happily, only a minority exposed to the influence of the poison are susceptible. Those in immediate contact or who have been in any way connected with the disease are put under suspicion, and yet the disease shews itself in an unexpected and unsuspected quarter, where seemingly no connection exists. But if, as I believe, the active agency of flies as carriers of contagion is susceptible of proof, this erratic behaviour of cholera is easily accounted for in localities where flies abound once an area becomes infected.

The occurrence of the second case is illustrative of this capriciousness. The prisoner was a man named Hari Charan Ahir, and he had been employed for some time with a gang of prisoners stone quarrying in the hills outside. He left the jail apparently in his usual state of health on the morning of the 12th July. About 9 o'clock A.M. he was brought back to the jail suffering from cholera and in a state of collapse.

Now no personal communication could possibly have taken place between this and the previous case, nor can any connection be traced between them. The *hajut* ward, however, is immediately in front of the yard and Barrack No. 1, where this prisoner fed and slept, and at feeding time the flies from the *hajut* yard find easy access to Yard No. I. Of course it is possible that this prisoner may have contracted the disease outside; but the occurrence of the case so soon after the first and other circumstances lead me to believe that this was not so.

For example, the third occurred in a Convict Overseer named Damri Pandey, who had not been outside the jail for nearly a month. He also was attacked on the 12th July at 9 P.M. He slept in the same barrack; but not the same ward as the previous prisoner. Being a Convict Overseer he was in a position to leave his own yard and go all over the jail.

The fourth case was connected with the same barrack. He was a Burman often previously in hospital and was again admitted on the 12th July for diarrhoea. He was there attacked by cholera on the 14th at 9 P.M.

We find after these cases beginning to occur in people connected with the hospital. But without entering into further details, analyses of the events connected with the outbreak go to shew that the disease smouldered from the 9th to the 20th. Six cases only occurred at varying intervals, then for some reason the climax of the epidemic took place, 11 cases occurring in three days. After this the disease and mortality began to decline. It may be noted that the mortality up to the 23rd was exceptionally severe, 14 out of 17 cases having died. Of 17 cases which subsequently occurred only six died, and the epidemic ceased on 2nd August.

Six cases occurred on the 22nd, three being from No. 9 Barrack, one from No. 1, one from No. 4 and one from the Convict Warders' room.

In connection with this latter case it may be stated that at the time of the outbreak there were five Convict Warders in the jail. When off duty they were permitted to occupy a small room on the lower floor of the hospital building. When, owing to its having become infected, orders were given to evacuate this building, it seems that the Warders did not obey the order; but continued to go back to their room and slept and ate their food either there or in the hospital verandah, which was always black with flies. Two out of the five took cholera and died, one having been attacked on 22nd and the other in camp on 26th.

On the morning of the 25th 325 prisoners were moved into camp and among them eight cases subsequently occurred. Eighty-seven prisoners were left in jail and among them also eight cases occurred.

As my object is to shew that on this occasion flies were mainly concerned in the diffusion of the disease, it will be necessary to make some remarks on the etiology of cholera, and I confess to entering upon this thorny subject with much hesitation. The disease and its diffusion have at various times been attributed to every conceivable cause—from Providence down to microbes. The latter appears to 'hold the field' at present. Many European authorities of great repute have quite accepted comma bacilli as the *causa causans* of the disease; recent investigations have proved the intimate association of these bacilli with the disease wherever found, but that they are the sole cause, cannot yet, I think, be accepted as an absolutely demonstrated fact. In no instance, either in animals or human beings (with one possible exception), has any experimenter succeeded in inducing a disease identical with Asiatic cholera, by means of comma bacilli. The exception referred to is one recorded by Metschnikoff. Last year he experimented on eight persons. After having neutralised their gastric juice by a dose of carbonate of soda, he caused them to swallow cul-

tivations of comma bacilli with the result that one got cholera, four diarrhoea, and three remained unaffected. If that one person had typical cholera it suffices to prove the case; but until the result has been disputed and further experiments have confirmed Metschnikoff's observation, the question of comma bacilli as the sole cause of cholera remains, I think, *sub judice*. It is, however, not necessary for my present purpose to profess an absolute belief in comma bacilli.

Without referring to mystical theories which most people have now abandoned it may be of advantage to state what we *do* know, and, keeping these facts in view, to inquire as to their bearing on the diffusion of the present outbreak.

We know that the poison, probably of microbic nature, which produces the malady, is contained in the excreta of affected persons, that the disease spreads from man to man by his habit of swallowing substances which have become contaminated; that contaminated water is a fertile source of infection; but that there are many other media, such as contaminated food of various kinds, milk, &c.

What is essential is that the poison should find entrance into the intestinal canal.

Given these cardinal facts, how did the disease spread in the Gaya Jail? I take it as established that the poison of the disease was introduced into the Jail by the under-trial prisoner whose history I have related. There was absolutely no sign or suspicion of disease—not even ordinary diarrhoea—before his admission. I have stated also the possibility that occurred of flies finding access to excreta which he passed in three different portions of the Jail. It will now be necessary to consider other possible sources of diffusion, and first the query arises, were the climatic conditions favourable to the reproduction of the poison? I think, so far as our present knowledge goes, this must be answered decidedly in the affirmative.

The meteorological conditions were very peculiar. There was practically a break in the rains lasting from the 9th to the 24th when very little rain fell, although the total for the month has exceeded that of any year for the past ten.

The temperature was high, the atmosphere close, and muggy, and moist, conditions under which, as is well known, the cholera poison rapidly develops. Further, the behaviour of cholera in both the town and district clearly indicates how the climatic conditions favoured development. Its history in the town begins with almost a total disappearance in January, reintroduction in February by pilgrims from the Kumbh Mela at Allahabad; then it continues smouldering for months until, while only 11 deaths occur in June, 154 are recorded in July.

The same on a large scale applies to the district, *viz.*, a gradual increase from February

onwards until, in the month of July, it bursts forth into a severe epidemic, and over 6,000 deaths occurred.

These facts point clearly to the favouring nature of the prevalent climatic conditions for rapid reproduction of the poison.

With regard to particular agencies connected with the Jail, the first requiring consideration is the water-supply. There is only one source of water-supply, *viz.*, a well situated in the Hospital compound. It supplies all the water required for drinking, washing, and bathing purposes. It is provided with a pump and was some time since covered over except where the pump is fixed.

By means of pipes water is distributed to all the bathing platforms of the Jail, and a pipe also pours the water for drinking purposes into a settling tank, whence it passes into a filter. From the filter the drinking water has to be carried and distributed by hand in covered pails. The water is of good quality. The well is about 40 feet deep; its tube is flush-pointed all the way down, and water can only enter from below; it is provided with a ring wall, so there is no possibility of surface water fouling it.

There are only two ways by which it could become contaminated by cholera poison, that is by underground percolation, and by a gust of wind carrying contaminated leaves or dust into it. The latter contingency would be one to be reckoned with if filth were allowed to accumulate which is far from being the case.

As regards the former it is not conceivable that cholera poison, whatever it may be, even if it existed on the surface near the well, could pass through so many feet of earth. Recent experiments have shewn that comma bacilli can be carried through  $2\frac{1}{2}$  feet of porous soil *by a current of water*.

As a matter of fact, I consider the well above suspicion, and in further proof of this I may mention that the Female ward of the Jail remained unaffected and all the Jail officials and their families who all drink the well water. Had it become contaminated it is in the highest degree unlikely that all these people should escape from shewing symptoms of the disease.

The latrine arrangements are on the usual dry-earth system and satisfactory; but in the ablution platforms a possible source of diffusion exists. A trough runs along the platforms containing water which is common to all, and if used by a sick prisoner might become poisoned. The next stage is, the hands of prisoners using it become contaminated, then their food, and so into their stomachs.

This may be said to be mere conjecture,—one does not see the process actually taking place; but to my mind it seems most probable that cholera can be spread in this way in susceptible subjects. This is not, however, the point I am at

present urging, but as bearing on it; and the question of soiled hands, an account of an epidemic at Leghour in 1893, is instructive, and goes to shew that of 22 cases first coming to knowledge 21 were females, all of whom had been washing in the public wash-houses.

In considering the influence of food and milk I come back to my original text 'the agency of flies,' for through these media their influence was, I believe, mainly exerted. Apart from them, both the food and milk were unexceptionable. During the epidemic the two principal meals of the day were mainly of rice, this being considered a more digestible article than wheat, which is usually given in Behar for one meal in the form of *chappatties*.

The milk used was from the Jail dairy, was of excellent quality—the cows being of a superior breed and well looked after—and could not possibly be contaminated in any other way than through flies. This again may be said to be conjecture; but it must be allowed that it possesses all the elements of probability. It was observed before the epidemic occurred that the Jail was infested with a plague of flies; disinfectants of various kinds were used, but they could not be got rid of. The moist, steamy weather appeared to favour their development. They were present in swarms when the disease broke out, and it was an observation of daily occurrence to see them settling on cholera stools whenever possible. *The rest can be imagined!* As soon as feeding time arrived, and the food was distributed in the usual way on open iron plates on the feeding platforms, there was at once a crowding of flies towards the platforms, and a struggle between them and the prisoners for the food. An active prisoner might possibly be able to protect his plate from contact with them; but many are careless and do not seem to mind much.

The same applies with equal if not greater force to milk which is even more difficult to preserve from them. When distributed in an open vessel to each prisoner it is almost impossible to keep flies away from it, and the prisoners receiving it were weakly and not active or energetic. It may be stated that the Jail milk on being taken from the dairy is first boiled so as to keep longer, then put away until it is time to distribute it.

Given therefore the presence of the cholera poison which as we know exists in the stools, the contact of flies with it, facts which were seen daily, their subsequent contact with food and milk, or even water, and it is not straining logic too far, I think, to assert that in this way the disease is capable of being diffused.

It was observed that several of those receiving milk daily were attacked. Of the 26 prisoners who suffered from the disease in Jail 12 were

in receipt of a daily allowance of milk. I have stated that the milk was of excellent quality and beyond suspicion if it could reach the prisoners without contamination, which could only have occurred through flies.

I found on one occasion that the Hospital Assistant had unnecessarily exposed it before distribution, and I therefore suspect that he had done so previously. It is in his special charge, and his orders are, after boiling, to keep it in covered vessels in a box in a room set apart for this purpose.

He had, however, with culpable thoughtlessness taken the vessel containing the milk for distribution into the dispensary which was in the Hospital—an infected building—and there I found it without a cover and full of flies. It was next door to this that the five Convict Warders lived, of whom I have already related that that two out of five died.

The subjoined table extracted from Jail Records shews the number attacked in Jail, those of them who received milk, their state of health, and other particulars:—

| No. | Name.            | Date of attack.  | Date of death.    | State of health before attack. | No. of times in Hospital. | If receiving milk in Jail. | Remarks where received from.                   |
|-----|------------------|------------------|-------------------|--------------------------------|---------------------------|----------------------------|--|
| 1   | Sukra Goala      | 9-7-94, 4 A.M.   | 9-7-94, 3 P.M.    | Bad ...                        | ...                       | ...                        | Hazaribagh, only 1 day in jail.                |
| 2   | Hari Choran Ahir | 12-7-94, 8 A.M.  | 15-7-94, 6 P.M.   | Good ...                       | ...                       | ...                        | Arrah.   |
| 3   | Damri Pandey     | 12-7-94, 9 P.M.  | 19-7-94, 11½ P.M. | Good ...                       | ...                       | ...                        | Ditto.   |
| 4   | Nga Aung Bow     | 14-7-94, 9 P.M.  | 15-7-94, 11 A.M.  | Indifferent, hospital ...      | 6 times.                  | Yes ...                    | Pegu, Burma.                                   |
| 5   | Bajraugi Bir     | 16-7-94, 11 P.M. | .....             | Bad ...                        | Once ...                  | Yes ...                    | Local.   |
| 6   | Udoy Mana        | 17-7-94, 8 A.M.  | 17-7-94, 7 P.M.   | Bad, hospital ...              | Twice ...                 | Yes ...                    | Midnapur.                                      |
| 7   | Boku Sheikh      | 20-7-94, 5 A.M.  | 20-7-94, 5 P.M.   | Indiff., Con. Gang. ...        | 4 times.                  | Yes ...                    | Ditto.   |
| 8   | Seojogi Ahir     | 20-7-94, 10 A.M. | .....             | Good ...                       | ...                       | ...                        | Arrah.   |
| 9   | Lachmi Pershad   | 20-7-94, 12 A.M. | 25-7-94, 10 P.M.  | Indifferent ...                | ...                       | ...                        | Saran.   |
| 10  | Bikan Ahir       | 20-7-94, 7 P.M.  | 25-7-94, 2½ P.M.  | Ditto ...                      | 5 times.                  | ...                        | Motihari.                                      |
| 11  | Gajadhar Chamar  | 21-7-94, 9 P.M.  | 22-7-94, 3½ P.M.  | Very bad, hospital ...         | ...                       | Yes ...                    | Local, only 6 days in jail.                    |
| 12  | Rupnarain Singh  | 22-7-94, 5 A.M.  | 22-7-94, 5 P.M.   | Indiff., Con. Gang. ...        | 3 times.                  | Yes ...                    | Local.   |
| 13  | Hari Chanda      | 22-7-94, 11 A.M. | .....             | Bad, Con. Gang. ...            | Ditto                     | Yes ...                    | Midnapur.                                      |
| 14  | Chand Ahir       | Ditto            | 23-7-94, 12 A.M.  | Good ...                       | ...                       | ...                        | Arrah.   |
| 15  | Tetar Chamar     | 22-7-94, 3½ P.M. | 23-7-94, 12 A.M.  | Indifferent... ..              | ...                       | ...                        | Local, only 10 days in jail.                   |
| 16  | Jadu Bera        | 22-7-94, 4 P.M.  | 23-7-94, 9½ A.M.  | Bad, Con. Gang. ...            | 7 times.                  | Yes ...                    | Midnapur.                                      |
| 17  | Khub Laul Singh  | 22-7-94, 8 P.M.  | 24-7-94, 9 A.M.   | Indifferent... ..              | 10 times.                 | ...                        | Saran.   |
| 18  | Jhingi Chamar    | 23-7-94, 8 A.M.  | .....             | Good ...                       | ...                       | ...                        | Arrah.   |
| 19  | Ram Sunder Ahir  | 25-7-94, 3 P.M.  | .....             | Good ...                       | ...                       | ...                        | Arrah.   |
| 20  | Inman Nagri      | 25-7-94, 4 P.M.  | .....             | Good ...                       | ...                       | ...                        | Local.   |
| 21  | Dipan Kahar      | 26-7-94, 7 P.M.  | 27-7-94, 11 P.M.  | Indifferent ...                | Once ...                  | ...                        | Ditto.   |
| 22  | Chuman Goala     | 28-7-94, 6 A.M.  | .....             | Ditto ...                      | 3 times.                  | Yes ...                    | Ditto.   |
| 23  | Jodunandan       | 28-7-94, 6 A.M.  | .....             | Ditto ...                      | Ditto ...                 | Yes ...                    | Saran.   |
| 24  | Kuar Dhaura      | 28-7-94, 6 A.M.  | 28-7-94, 4 P.M.   | Bad, hospital ...              | 7 times.                  | Yes ...                    | Midnapur.                                      |
| 25  | Jagan Chamar     | 30-7-94, 5 A.M.  | 31-7-94, 11 A.M.  | Very bad, hospital ...         | ...                       | Yes ...                    | Admitted direct to hospital on 15th July 1894. |
| 26  | Ramdhani Ahir    | 2-8-94, 1 A.M.   | .....             | Good ...                       | ...                       | ...                        | Arrah.   |

It will be seen that the cases among those receiving milk occurred in groups, which would point to contamination on certain dates. The marks ° \* in the block plan show the barracks which those attacked were connected with, and it will be seen that the whole Jail, with the exception of the Female ward, became infected. This latter has a very high enclosure wall which protects it to a great extent against flies.

Holding the views regarding the active agency of *flies* which I have above set forth, it became a problem of great importance to prove, if possible, whether they could contaminate milk, for instance, and I have to acknowledge I here with much pleasure the willing assistance I received from M. Haffkine, who was kind enough to carry out the details of the following experiments which was made about the end of July.

It was intended to discover, if possible, whether flies could carry comma bacilli into milk.

A portion of Jail milk was first sterilised by boiling, and sub-divided in nine clean earthen

vessels which had never previously been used, and then exposed to flies in three separate portions of the Jail, *viz.*, the *Hajut* ward (which was at this time occupied by cholera patients) and enclosure latrine, the Hospital wards, dispensary, and verandah, and the dairy building, and the latrine in its enclosure.

Meantime some sterilised 'bouillon' was prepared, made slightly alkaline and divided into six portions, in six glasses carefully boiled. With a few drops of the exposed milk, each portion of bouillon was inoculated, carefully covered over, and left in a covered place excluded from light for twenty-four hours.

After this period a scum had formed on the top of the bouillon. From this again, by means of a sterilised needle, cultivations were made in agar-agar tubes.

On examination of these after twenty-four hours elapsed, it was found that in each case mixed cultivations had resulted, but at certain points, in almost all, characteristic colonies of

commas was apparent. Preparations were made at the time and put aside for further examination under the microscope by the immersion system, and M. Haffkine took away the preparations as well as the tubes to Calcutta to endeavour, if possible, to obtain purer cultivations from them.

The result he has now communicated to me, and is as follows:—"I tried to renew the cultures I brought from Gaya. I succeeded only with the comma bacilli from the milk exposed in the Hospital verandah and dispensary, and preparations made with them and which we examined yesterday together, Dr. Simpson and I have not the slightest doubt of their authenticity."

Further he states: "I kept with me the original preparations made in Gaya. In these preparations, examined by Dr. Simpson and myself with the immersion system, a most characteristic form of commas is to be seen from the milk exposed in the *cowshed and cowshed latrine*."

"The other Gaya preparations contained commas too, although not in such a characteristic state."

Here then we have the testimony of two competent observers that comma bacilli were found in the milk which had been exposed in open vessels in the Jail which swarmed with flies. There can have been no other possible way except the flies by which commas could have got into the milk unless it were through the air, and I believe that comma bacilli have hardly ever been found in the air. I confess to having been surprised on hearing of commas having been found in the preparation from the cowshed and cowshed latrine. There was of course no case of cholera in the dairy, nor had the latrine been at any time used. But it will be seen from the plan that the incinerator is quite near this building, and that all cholera excreta would therefore be carried in this direction no doubt with an accompanying contingent of flies which would visit the dairy and latrine *en route*.

To many no doubt this experiment will prove an additional argument in favour of the theory that comma bacilli are the cause of cholera, but to appreciate its significance it is not by any means necessary to be a believer in 'comma bacilli' as the sole cause of the disease. It is a logical argument that if flies can carry comma bacilli from a cholera stool, they can equally carry cholera poison, whatever it may be, which we know does exist there. Besides we do possess distinct evidence that comma bacilli are capable of giving origin to a deadly poison.

To us in India the gravity of the issues to be deduced from the experiment can scarcely be exaggerated, and I trust that perhaps others may undertake investigations in the same direction, with either milk, boiled rice, wet *chappatties*, or flour or any other kind of food to which flies are partial. No doubt we shall bye-and-bye find some means of dealing with them effectively.

The practical lesson the experiments teaches is, that flies should be looked upon in the light of poisonous agencies of the worst kind during cholera epidemics, as it is clear that if they find access to poison they will carry and distribute it, and every possible means should be taken to prevent their getting into contact with either food or drink of any kind, and to those having to deal with large bodies of men it is a lesson more easily learnt than put into practice.

Finally, I have to express my sincere thanks to Mons. Haffkine and Dr. Simpson for having kindly completed the experiment.

## THE DISINFECTION OF WELLS. ✓

BY E. H. HANKIN, M.A.,

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[From the Government Laboratory, Agra.]

MANY years before microbes were thought of the fact that water containing organic matter is often harmful to health was known and acted upon. This was the case, although only the vaguest ideas existed as to the nature of the infective material, and as to how it found its way into the Well. If the water was shown by a chemical analysis to contain more than a certain quantity of free or albuminoid ammonia, the rule was, and is, to close the well and to make another. It appears to me that, in the light of our present knowledge, this rule is somewhat crude and might on many occasions be modified. We now know the occasional harmfulness of organic matter in water to be due to the presence of disease-producing microbes. We also know that these microbes are capable of being killed and rendered harmless by means of disinfectants. It appears to me strange that no one has yet made the obvious deduction from these facts that an infected Well may be rendered fit to drink by the addition of suitable disinfectants. If any one has made this deduction, I much regret that the discovery is not yet sufficiently known for me to be able to cite it. The most I have yet heard of in this direction is cleaning a well or clarifying its water by means of potassium permanganate or by alum respectively, neither of which substances have the reputation of being efficient antiseptics.

I by no means wish to assert that a Well must necessarily be a good source of water because the microbes that it contains have all been killed. We are far from knowing everything about the metabolism of microbes in test tubes, still less is known of the chemical changes they may take part in in a Well. It is very probable that the not-living organic matter in a water-supply, though not directly harmful, can act as a food material for microbes, and for this reason its presence is objectionable. European observers