

outburst in the Yellowstone Park of a geyser which has been quiescent for four years.

All the evidence so far published tends to show that the earthquake was a true seismic disturbance, which was probably transmitted along certain lines of great rock-masses, or along lines of weakness; but details to enable us to determine these points are not yet to hand.

DR. KLEIN'S REPORT ON MILK SCARLATINA

IN a recent Report to the Local Government Board, "On Certain Observed Relations between Scarlatina in various Districts of London and Milk supplied from a Dairy Farm at Hendon," Mr. Power has related the circumstances (NATURE, vol. xxxiv. p. 393) under which I became associated in inquiry at the farm in question; and, while briefly indicating certain provisional inferences of my own as to the nature of the malady discovered among the cows there, Mr. Power goes on to promise an account by me of the special features and pathology of the disease. This I now proceed to give.

The cows (I. and II.) which were the first subjects of my investigations had on the teats and udder several flat irregular ulcers, varying in diameter from  $\frac{1}{4}$  to  $\frac{3}{4}$  of an inch; some ulcers were more or less circular, others extended in a longitudinal direction on the teat. The ulcers were covered with a brownish or reddish-brown scab, which, when scraped away, left exposed a granulating slightly indurated base. The margin of such ulcer was not raised, nor was there any perceptible redness of the skin around. But where I afterwards got the opportunity of watching the earlier stages (especially in animal IV.) it was noticed that a small vesicle made its appearance on a greatly swollen and red teat, in the course of a couple of days assuming the character of the above ulcers. In another cow, an ulcer about  $\frac{1}{2}$  inch in diameter, was becoming covered in its central part with a scab, while at its margin vesiculation was still distinctly visible.

As a rule, *i.e.* in most animals, the disease affected the teats, but in some there was also on the lower part of the udder here and there an ulcer. In such animals, patches denuded of hair were noticed on various parts of the skin, the tail and back particularly. In these patches the epidermis was scaly, and the cutis more or less thickened. The animals looked thin, but not strikingly so, except in one or two cases of animals that had only a few weeks ago been admitted to the place, and which therefore had calved comparatively recently (see Mr. Power's Report). As regards the feeding capacity of affected animals, their milking power, and their body temperature, nothing abnormal could be detected.

Two animals (to be referred to as cow III. and cow IV.) became the special subjects of study after they had been removed from the farm to the stables of the Brown Institution.

The temperatures (Centigrade degrees) of cow III. were as follows:—

|                  | Morning temperature | Evening temperature |
|------------------|---------------------|---------------------|
| January 4 ... .. | 38·8                | 38·7                |
| " 5 ... ..       | 38·9                | 38·9                |
| " 6 ... ..       | 38·8                | 38·3                |
| " 7 ... ..       | 38·9                | —                   |
| " 8 ... ..       | 39                  | 39                  |
| " 9 ... ..       | 38·8                | 38·7                |

The temperature afterwards remained as above without alteration.

The temperatures of cow IV. were:—

|                  |      |      |
|------------------|------|------|
| January 6 ... .. | 38·4 | 38·3 |
| " 7 ... ..       | 38·7 | —    |
| " 8 ... ..       | 38·4 | 38·8 |
| " 9 ... ..       | 38·6 | 38·5 |

In animal III. the ulcers were present, and on January 4 were at their full development and covered with crusts. They gradually died away, and subsequently healed up by January 10, leaving, however, a whitish indistinct flat scar.

When this animal was received there were noticed on its coat several patches where the hair was gone, and the epidermis was rough and scaly.

Animal IV. when received showed several scabs in the skin of the back; it had also muco-sanguineous discharge from the

vagina (the animal was in the third month of pregnancy) and redness and excoriation of the mucous membrane of the vagina. One teat, which was much swollen and inflamed, presented in several places brownish crusts. These when taken off left an infiltrated firm sore, from which, when squeezed, a thickish lymph oozed out. Similar crusts were found on other teats and on the udder. The greatest development of the sores in this cow was on January 7. On January 9 the sores were decreasing; the animal was then killed.

On opening the chest it was found that both lungs exhibited in the upper posterior lobes numerous petechiæ under the pulmonary pleura, the peripheral lobules of these parts being much congested. There were numerous adhesions by recent soft lymph between the lower lobes of the lung and the costal pleura, particularly laterally. In the liver there were several reddish streaks and patches, reaching from the surface of the organ to a depth of about a quarter of an inch. In these patches the liver tissue was much softened. The spleen and kidneys, with exception of slight congestion, appeared normal. In the placenta there were numerous petechiæ.

Cow III. was killed on March 12. For some days previously the animal had been getting very thin, notwithstanding its ravenous and excessive eating. On post-mortem examination the following appearances were found:—

In the lungs there were numerous lobules, especially in the peripheral parts, which showed great congestion; there were in addition pleural adhesions; the cortex of the kidney was congested, but its medulla was pale.

Experiments were now made with the matter of the ulcers, with a view of ascertaining whether or not the disease was transmissible to other animals.

On January 7, when the ulcers of cow IV. had reached their maximum development, I took scrapings from some of the ulcers on the udder and teats, having first removed the crust, and inoculated in several places the skin of groin and inside of ear of two calves (1 and 2). For inoculation a superficial small incision (not longer than about a quarter of an inch) was made, passing in an oblique direction through the superficial part of the corium, and into this pouch a particle of the scraping was rubbed.

On January 9, with scraping of ulcers of the cow before she was killed, I inoculated two calves (3, 4), introducing the matter as before into the corium of the groin and of the inside of ear.

Calves 1 and 2 showed during the first three days after insertion of the matter no change at the seat of inoculation.

Four days after inoculation:—There was in calf 1 one place in the groin which promised to become an ulcer. Calf 2 showed on the ear one promising place, the other places of inoculation having nearly healed.—At the same distance of time after inoculation calf 3 showed two promising places on the ear, and calf 4 showed two promising places in both groin and ear. Calf 3 also showed a kind of vesiculation at the margin of the spot inoculated and commencing formation of a crust in the centre. What I call promising places of inoculation were spots that had become swollen and tender, the other and not promising places were spots that seemed healing or were already healed and dry.

On the sixth day:—Calf 1 showed four successful places in the groin; the places had become swollen and enlarged with imperfect vesiculation at the margin and formation of crust in the centre. Calf 3 had four successful places on the ear, and calf 4 had the same number in the groin.

On the seventh day:—In calf 1 all places except one in the groin had nearly disappeared. This place was now a distinct ulcer covered with a crust, on removing which a granulating infiltrated base was exposed. In calf 2 all places of inoculation were decreasing, covered with small scabs, easily detached. In calf 3 the sores on the ear had enlarged to about half an inch in breadth, each of them covered in their whole extent by a brownish crust. In calf 4 all except one place on ear were healing.

On the eleventh day:—Calf 1 had still one ulcer in groin not yet healing. Calf 2 had one ulcer on ear not quite healed up. Calf 3 had four big ulcers still progressing; crusts thick, and corium much indurated. Calf 4 had one ulcer on ear much diminished in size.

By the eighteenth day:—The ulcerations in calf 3 (one ulcer had been cut out for microscopic examination) had all healed up and become converted into flat scars. In the other animals the healing was completed at an earlier date.

Simultaneously with the above experiments several inoculations with materials of the ulcer of cow No. IV. had been made into the skin of the groin of ten guinea-pigs and of three dogs. In the guinea-pigs no result was obtained; but in one of the dogs one place of inoculation appeared swollen and inflamed on the third day. On the fifth day this place was an oblong ulcer of about a quarter of an inch in diameter; the margin was red and swollen, but the centre was without crust (the animal had been frequently seen to lick it). On the seventh day the ulcer was much smaller, and it had nearly healed up by the tenth day.

From these experiments there can be no doubt whatever that by inoculating a particle of matter from the sores of an affected cow a positive result has been obtained in all four calves. In calf 3 this result was best and most striking. After an incubation of about three days the places of inoculation became swollen, tender, and spreading; on the fifth to the sixth day the change was distinct, the successful places having become sores; in the marginal part showing vesiculation, and in the centre formation of crusts. The sore enlarged during the next few days, and on removing the crust a raw surface was exposed, the corium itself being found infiltrated. According to the intensity of the process the retrogressive change sets in later or sooner; in slight cases the healing begins about the ninth or tenth day, in severe cases (calf 3) not before the end of the second week.

Having thus demonstrated this disease of the cow to be directly communicable from animal to animal, I set to work to study its minute anatomy.

The microscopic examination of fine sections through the ulcer of the cow shows the following conditions:—

The corium throughout the whole extent of the ulcer is infiltrated with round cells. This infiltration, though densest in the central portions of the ulcer, is sufficiently pronounced even in the peripheral parts, but it gradually fades away on passing from the ulcer to the normal skin. The infiltration in the deeper parts of the corium is limited to the vascular branches, but in the superficial parts is more diffuse, the papillæ becoming at the same time thicker. This thickening of the papillæ fades off towards the periphery of the ulcer. The most noteworthy changes are, however, present in the epithelium. In the peripheral portions of the diseased part there are present in the superficial layers of the stratum Malpighii close to the stratum lucidum, as also in the stratum lucidum itself, numerous cavities of different sizes. These cavities lie closely side by side; the most superficial ones are either covered by the stratum lucidum or extend between the layers of this stratum. The former cavities descend into the depth of the epithelium; at the very margin of the diseased part they are smallest, and they do not in depth comprise more than the superficial third of the stratum Malpighii. They enlarge in depth gradually as we pass from the periphery of the ulcer towards its centre; at its very centre they involve the whole thickness of the stratum Malpighii. At the same time it is to be noticed that, at the marginal parts, the cavities, although closely placed side by side, are well separated from one another by thicker or thinner trabeculæ composed of epithelium; while at or near the centre the ulcer these trabeculæ get destroyed, and the cavities become confluent, and the covering layers of the cuticle having here also given way, their contents extend on to the free surface of the ulcer. These contents, which go to form what has been above mentioned as the crust, spread thus gradually over the surface, not only of the centre, where the stratum lucidum has become lost, but also over the rest of the ulcer. In the marginal positions, *i.e.* where the superficial layers of the cuticle are still present as cover of the above cavities, this layer (*i.e.* the stratum lucidum) separates the contents of the cavities from the crust. The contents of these cavities consist (*a*) of an albuminous fluid looking, in hardened sections, uniformly granular or containing also fibrinous threads; (*b*) of a few red blood corpuscles; and (*c*) chiefly of round cells or pus cells, the nuclei of which, near to and on the surface, gradually break up into amorphous granular matter.

In the central parts of the ulcer the whole exudation undergoes degeneration into debris, and not only in its superficial, but also in its deeper portions. While some cavities contain very few cells and are filled chiefly with albuminous fluid (granular or fibrinous), others are almost entirely filled with pus cells closely packed together. In the papillæ near the cavities the blood-vessels are engorged and there is also escape of red blood disks.

On a careful examination it is evident that the origin of these

cavities is in enlargement of and exudation into the tissue of the papillæ, but only of those portions nearest to the stratum lucidum, and from hence arises formation of cavities in the cuticle. The whole anatomical details of the distribution and arrangement of these cavities recall vividly the conditions observed in the vesicles of cow pock and of sheep pock, and on comparing under a low power of the microscope a section through a sheep pock with a section through the ulcer of the cow now under consideration, the similarity is very striking indeed.

There are, however, anatomical differences between the two diseases. The infiltration of the corium is slighter in the cow ulcer than in the sheep pock, and in the cow ulcer the cavities form in a more superficial stratum of the epidermis.

There is in the disease we are now considering a good deal of infiltration of the epithelium by round cells derived from the cavities, not only into the stratum Malpighii, but also, and particularly in the marginal parts, into the cuticle; the round cells burrowing in great numbers between the scales of this stratum, and ultimately reaching the free surface to join those of the crust.

Fine sections made through the ulcer artificially induced by inoculation in the ear of calf 3, proved its complete identity in anatomical respects with the ulcer in the cow. The infiltration of the superficial corium; the formation of cavities, filled with exudation cells and fluid, in the superficial layers of the epithelium, particularly between the layers of the cuticle; the final destruction in the centre of the ulcer of the covering cuticle; and the extension of the exudation over the free surface to form here the crust, are the same in both instances.

Microscopic examination of the internal organs of cow IV. revealed facts as follows:—

*In the lung.*—Sections made through the portions above mentioned as containing much congested lobules, show not only great congestion of the blood vessels, large and small, but a large amount of hæmorrhage; blood in substance being present in the air vesicles and infundibula, in the lymph spaces of the interlobular septa, and in the tissue and lymphatics of the pleura. In the latter membrane numerous diplococci are to be met with. Here and there the same diplococci occur in the alveolar wall and in the tissue of the interlobular septa.

Sections through *the liver* show a great deal of change. Under the capsule, as well as in the substance of the liver, there occur, in connection with the interlobular branches of the portal vein, larger and smaller foci of inflammation, consisting in the presence of numerous round cells. Some of these foci are several millimetres in diameter, others are very small. From the interlobular tissue the inflammation extends into the lobules between the liver cells. The liver cells of these lobules involved in the inflammatory process are swollen up, and many of them are undergoing disintegration. In some of these foci, particularly those situated in the vicinity of the capsule, the round cells are so much crowded that given foci look almost like miliary abscesses. The blood vessels are much distended and filled with blood.

Numerous diplococci and short coccus chains occur in the parts surrounding the inflammatory foci. These are particularly numerous near the capsule in the vicinity of inflamed parts.

Sections through *the kidney* showed well-marked glomerulonephritis; infiltration of the sheath of the cortical arterioles with numerous round cells; the epithelium of the convoluted tubules swollen, opaque, and in many places disintegrating.

The lungs and kidney of cow III. showed on microscopic examination the same appearance as in cow IV.; in addition there was a good deal of round-cell infiltration in the wall of the infundibula and bronchi in the lung, and around the cortical arterioles in the kidney. In the blood-clots filling the alveoli and small bronchi of the lung there were present larger and smaller clumps of micrococci.

Search was now made for micro-organisms inhabiting the tissues of the ulcer of the cow, with a view of ascertaining what were present, and afterwards whether any single kind of those found had the power, when dissociated from the diseased tissues and inoculated into healthy animals, of transferring the disease.

Removing the crust, scraping off the most superficial layer, then squeezing the ulcer so as to collect a droplet of lymph, I spread it in thin films on cover-glasses, and dried, stained, and mounted the several specimens in the usual manner. Such a specimen, examined under the microscope, revealed a number of red blood disks, mixed up with large numbers of pus cells, each of which contained two, three, or four small nuclei and remnants of epi-

thelial cells. Amongst the pus cells numerous dumb-bells of micrococci (or diplococci), and a few short chains of the same, were met with. In size these micro-organisms do not differ from those described in connection with foot-and-mouth disease. In many sections—stained in fuchsin, or in methyl blue, or in gentian violet—through the diseased tissue of the cow, as well as that of calf 3, there were found the same diplococci and chains in the contents of the superficial cavities, as well as in the depth of the epithelium. In the latter stratum they were met with abundantly throughout the whole extent of the marginal portion of the ulcer, but not beyond it. In the superficial parts, namely, in the contents of the cavities in the stratum lucidum, the same chains were to be found, provided the pus cells were not too closely packed. They were very numerous in the tissue of the crust, and also in the superficial central portions of the ulcer that had undergone degenerate change. There occurred also in the crust and in the necrotic parts of the ulcer numerous clumps of zooglea of micrococci; but these micrococci are not to be confounded with the chains of streptococci to be presently described, nor yet with those streptococci which are found occurring singly.

From the deeper parts of an ulcer of cow IV. material was obtained with which tubes containing either solid nutritive gelatine, or Agar-Agar mixture, were inoculated. After some days, and in both media, a micrococcus appeared, the growth of which was extremely characteristic. These are its characteristics, in the nutritive gelatine: after 3 to 6 days' incubation at 20° C., the growth made its appearance at the point or line of inoculation, in the form of small points or granules, whitish in colour and tolerably closely placed. During the next few days their number and size increased. At the end of a fortnight the line of inoculation was visible as a streak of whitish granules or droplets, some large, others small, more or less closely placed. On the surface of the gelatine the growth, like a film of granules, spreads slowly in breadth, but even after months remains small. When inoculated into the depth of the gelatine, the channel of inoculation becomes visible as a whitish streak, made up of smaller and larger droplets. The gelatine is not liquefied by the growth. The same characters are assumed by the growth in Agar-Agar mixture and in solid serum. The general aspect of the growth in gelatine, in Agar-Agar, and in serum, is very similar to that presented by the *streptococcus* of foot and mouth disease (see my report of this year upon that malady<sup>1</sup>), but with this difference, namely, that in gelatine tubes the streptococcus of foot-and-mouth disease is a little faster in its growth, and its component granules are a little more distant. Nevertheless, I have tubes of both kinds of organisms in gelatine and in Agar-Agar—tubes which cannot be from their general appearance easily distinguished. In faintly alkaline broth, or in broth and peptone, the micrococcus of the cow ulcers grows readily, and in the same manner as that of foot-and-mouth disease. But there is one test by which the two kinds of organism can be very readily distinguished: the streptococcus of foot-and-mouth disease, when grown in milk, does not affect the fluid character of the milk, whereas milk inoculated with the organism obtained from the cow's ulcer will, if kept for two days in the incubator at 35° C., have been turned completely solid. This difference is a very striking difference, and a few days' growth in milk suffices for distinguishing without fail between the two.

The microscopic examination of a culture in broth peptone, in gelatine, or in Agar-Agar mixture shows that the growth consists of spherical micrococci, arranged as diplococci, and as shorter and longer straight, wavy, or curved chains—streptococcus,—these latter sometimes of great length. As regards the shape of the micrococci, the mode of their division, the branchings of the chains, the presence here and there in the chain of a large element amongst the smaller ones, the organisms of the ulcers hardly differ from the description which I am preparing of the streptococcus of foot-and-mouth disease. The elements of a coccus chain of the foot and mouth micro-organism are, however, smaller than those of the disease under consideration.

The streptococcus chains of a growth in broth are short during the first few days; but later on, when the growth settles down more into the deeper parts of the broth, the chains become of great length. So also in Agar-Agar tubes of one to two or more weeks' incubation.

A curious fact, to which importance must provisionally attach, is this: In a cow having several of the ulcers on the teats, the

fingers of the milker pressing over the ulcers would constantly rub off from the latter particles of matter, and the fingers and the teat being kept moist, this matter would easily mix with the milk as it passes from the teat. To learn whether the milk while in the udder contained the streptococci, the following experiment was made: A teat free of any ulcer was milked so as to obtain a few ounces of milk, and from this milk a large number of gelatine and Agar-Agar tubes were inoculated; a second teat of the same cow, affected by an extensive ulcer, was milked to the same extent, and from the milk thus obtained a large number of other gelatine and Agar-Agar tubes were inoculated. In the first series no single tube showed the growth of the above-described streptococcus, whereas in the second series one gelatine tube and one Agar-Agar tube were found to develop the typical growth of the streptococcus.

We cannot draw any certain inference from this one observation, but evidently the experiment deserves repetition.

With a cultivation (a third sub-culture) in Agar-Agar mixture of this streptococcus, I, on February 1, inoculated subcutaneously in the groin two calves (5 and 6). On February 27 calf 6 was found dead. The subcutaneous tissue at, and for some distance around, the seat of inoculation showed much effusion, and the inguinal glands were swollen and red. There was peritonitis, with sanguineous exudation, congestion, and hæmorrhagic spots in omentum and in the serous coat of the stomach. The spleen appeared small and its capsule thickened. The liver was greatly congested. Kidneys were large and much congested. The ileum was much congested in its mucous membrane, and the epithelium detached in flakes. The mesenteric glands belonging to the ileum were greatly enlarged and hyperæmic. Both lungs were congested, the superficial lobules showed so much congestion that they looked almost solid, and were of a deep red colour. A few petechiæ under the pleura. Bronchial glands enlarged and congested. There was pericarditis, and the heart was distended by, and filled with coagulated blood. The organs of the throat were found much congested. The hairy parts of the skin were not examined.

Calf 5 showed on March 7, around the nostrils and lips of the mouth, and on hard palate and gums, numerous irregularly outlined patches not raised above the level of the skin. These patches had a discoloured, brownish, very slightly raised margin, and a paler centre; they were round or irregular, some as small as  $\frac{1}{8}$  of an inch, others four to six times larger. The animal was killed on March 8. On post-mortem examination the following appearances were noted: Congestion of some of the peripheral lobules in both lungs; the pleura pulmonalis slightly opaque, numerous soft lymph adhesions between it and the costal pleura; in the spleen several hæmorrhagic patches under the capsule in the shape of bullæ filled with semi-congealed blood; spleen pulp softened and very congested; kidney congested; organs of the throat congested.

There can then be no doubt that a definite disease has been produced in both animals, of which the affection of the lungs is a conspicuous feature, and coincides with, though more pronounced than, the lung disease noticed in cow IV.

In calf 5 there was, in addition, the disease of the skin and in the mouth, which, as the microscopic examination proved, is in a certain degree similar to the disease in cow IV. and calf 3. More in detail, this is what is found as regards the skin: The tissue of the papillæ and of the superficial corium is infiltrated with round cells, and the blood-vessels of the papillæ are distended and filled with blood. In their peripheral portions, their most superficial parts, the papillæ are very much distended by extravasated blood and round cells;—in fact the first rudiments of cavities are forming in them. The same condition, but more pronounced, obtains in the cuticle, where between its layers there are present small cavities filled with blood and round cells, or only fluid and a few round cells. There is, in addition to this, a general infiltration with round cells of the layers of the cuticle. The brownish-reddish colour of the marginal parts is due to this condition. In the central part the cuticle is loosened by the formation of such cavities containing fluid and a few round cells; by this its layers were separated and ultimately detached. In the cavities of the cuticle occur very fine diplococci and chains. So also in the infiltrated and enlarged papillæ, and in the deeper layers of the epithelium in the whole extent of the diseased skin, diplococci and short chains are present.

In neither of these cases of subcutaneous inoculation was there found any rent or breakage of the stratum Malpighii, *i.e.* no real ulcer. The anatomical features here described in many respects

<sup>1</sup> To appear in the Supplement to the fifteenth volume of the Board's Reports.—G. B.

resemble the lesion of the skin in human scarlatina (see my report for 1876). I did not, unfortunately, look at other (the hairy) parts of the skin to see whether there were any such patches in this calf. (Some observations on the kidney of calf 5 are noted in the sequel.)

Examination of the organs of calf 6 :

(a) *The lung.*—Congestion of all blood vessels, large and small. Transudation of fluid and hæmorrhage into the alveolar cavities of part of some lobules of the lung, while the rest of the alveolar cavities are collapsed, the capillaries around them very much congested; infiltration with leucocytes of the interlobular septa, extending also into the inter-alveolar septa. In some of the lobules next to the pleura the engorgement of the capillaries is extremely great, blood *en masse* filling the alveoli to the extent of producing a state of red hepatisation. The pleura itself is thickened by exudation of fluid and leucocytes. The bronchi do not show any distinct alteration. Numerous diplococci and a few chains are met with in the pleura and in the congested parts of the lobules, in the alveolar wall, and in those alveolar cavities which contain exudation and blood. The bronchial glands show great changes: the capsule and septa being much thickened by exudation and leucocytes; the lymph vessels everywhere filled with round cells; the tissue of the follicles and medulla much swollen.

(b) *The liver* shows extreme congestion of all vessels in all parts, inter- and intralobular. The liver-cells are opaque, granular, and atrophic.

(c) *The ileum.*—The epithelium of the surface detached and gone; the epithelium of the Lieberkühn follicles loosened, and in most places detached; the mucosa shows great congestion and infiltration; in the superficial layers the villi show hæmorrhage, the tissue being filled with blood corpuscles, fibrin, and leucocytes; and in many spots the superficial layers of the mucosa are necrotic.

The Peyer's glands are much swollen and inflamed; the central portions of their follicles are breaking down.

Micrococci and bacilli pervade everywhere the tissue of the mucosa. The mesenteric glands in relation with the ileum have their capsules, septa, follicles, and medullary cylinders much congested and inflamed.

(d) *The kidney.*—The changes in this organ are highly interesting, since they completely coincide with those in acute scarlatina nephritis in man: great congestion of the cortex, leading in some parts to hæmorrhage into the parenchyma; glomerulo-nephritis with exudation of albuminous fluid and blood into the cavities of the Malpighian corpuscles; granular or opaque swelling of the epithelium of the uriniferous (convoluted) tubules, with degeneration into granular debris of many of the epithelial cells; miliary foci of aggregations of round cells around small bloodvessels; congestion of the medulla.

[The kidney of calf 5 was also examined microscopically, and the changes were exactly the same as those found in the kidney of calf 6, viz. congestion of the glomeruli, glomerulo-nephritis, transudation of albuminous fluid and red blood corpuscles into the cavity of Bowman's capsule; opaque swelling of the epithelium of the convoluted tubules; granular disintegration of the epithelium in many places; infiltration with round cells around some arterioles of the cortex; and congestion of the medulla.]

(e) *The heart's blood* was examined for organisms, and in it, by the staining with Weigert's gentian violet, a few diplococci and a few chains could be distinctly detected.

Cultivations were made with this blood in tubes containing Agar-Agar mixture, and a growth of the streptococcus was obtained in all respects identical with the streptococcus that had been employed for inoculation of this animal.

In view of the whole of this evidence, I consider it conclusively established that this streptococcus is identical with the virus of the cow disease.

We have, then, inoculated subcutaneously with sub-cultures of the streptococcus these two animals, calves 5 and 6, with the result of producing a general disease, which in many respects bears a close resemblance to human scarlatina. The minute anatomical characters of the eruption on the skin around the nostrils and mouth in calf 5 is of much significance in this connection, as also is the disease in the liver in both animals, and above all, the disease in the kidney. This latter organ corresponds so closely with a kidney of an acute case of human scarlatina that sections made of the one and compared with those of the other, of which I preserved a large collection from my

former investigation into the anatomy of human scarlatina (see Medical Officer's Report for 1876), show no difference whatever.<sup>1</sup>

The outcome of the investigation thus far, and it is of importance until further differentiated observations shall have been made, may be stated thus:—By inoculating the virus directly taken from the local disease (the ulcer on the teats) of the cow into the corium of the calf the same local disease is produced, namely, a change in the skin, which commences as a congestion of the papillæ and corium, and an exudation of fluid and leucocytes. This leads, in the superficial parts of the epidermis, to the formation of cavities, which, enlarging, and extending, and opening on to the surface, and extending into the depth, ultimately lead to the formation of an ulcer. But the virus, in the form of an artificial cultivation of the streptococcus derived from the above ulcer of the cow, when inoculated into the subcutaneous tissue, that is, when introduced almost directly into the vascular system (for all matter injected subcutaneously is easily absorbed by the lymphatics and carried into the blood system) sets up a general disease resembling to a considerable degree in its anatomical features human scarlatina.

Furthermore, as respects the concern that cow's milk may have in the communication of disease—the consideration which led to the present investigations—we have some facts which appear to me to afford very suggestive indications for further pathological study. As I have pointed out on a previous page, it would seem that the milk pure does not contain the organism, but (whether or not this observation be confirmed) the milk during the act of milking is pretty sure to become contaminated by the fingers of the milker bringing down into the milk particles from the ulceration on the teat. The organism contained in these particles would find in the milk a good medium in which to multiply. Such milk would then practically correspond to an artificial culture of the streptococcus, such as we have found capable of setting up a general disease, when inoculated subcutaneously into calves. It is true we have as yet no experience of the inoculation of a known milk sub-culture into the human subject, but in the case of calves we have learnt that the general disease resulting from inoculation of an Agar-Agar sub-culture had characters closely allied to, if not identical with, human scarlatina. Then, feeding of animals with the cultures has not yet been tried, so that at present we are without information as to the characters of any disease that may be produced in calves by that means; whether or not calves fed with milk sub-culture of our streptococci exhibit the same pathological states as we have found to be produced by inoculation of calves with an artificial culture—states that bear so marked a resemblance to those of scarlatina in the human subject. In order completely to understand these and other relations, more experiments are required, and these I hope soon to have an opportunity of making.

Until I am in a position to state at greater length the peculiarities of the infective phenomena of the disease under consideration, I refrain from further comment on its various interesting and promising aspects.

## THE BRITISH ASSOCIATION

### SECTION E

#### GEOGRAPHY

OPENING ADDRESS BY MAJOR-GENERAL SIR F. J. GOLDSMID, K.C.S.I., C.B., F.R.G.S., PRESIDENT OF THE SECTION

HOWEVER diffident I may feel in undertaking the duties of President of the very important Section of Geography at this anniversary, I have no right to take shelter under that diffidence for any shortcoming in the fulfilment of my task. All I would seek at your hands is indulgence for one whose training and antecedents have scarcely fitted him for appearing before you in a quasi-professorial capacity, and whose brief tenure of a Presidential chair at a meeting such as this must be regarded as rather an incidental passage in the annals of the British Association than a fair illustration of its *modus operandi*, or principle of selection in respect to its officers.

As to the subject of my opening address, I know none more befitting the occasion than the means of popularising the branch

<sup>1</sup> Referring to the commencement made in 1882 of investigation of the results producible in the cow by inoculation with the material of human scarlatina, see p. 67 of report of that year, I would propose that this study be extended without loss of time.