BACILLUS MORTIFERUS (NOV. SPEC.).

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It is proposed in this paper to describe a hitherto unknown bacillus which is pathogenic for man and animals.¹

Source.—From an abscess in the liver of a person who died and came to autopsy in the Johns Hopkins Hospital on October 13, 1900.

Clinical Report.—For the following clinical notes I am much indebted to the kindness of Professor William S. Halsted, under whose care the patient was admitted.

J. B., æt. 44. Admitted to the Johns Hopkins Hospital October 6, 1900. The family and past histories are unimportant.

Present Illness.—Note of October 6: The patient was admitted with a history of headache of four days' duration. Three days before admission nausea began, accompanied with vomiting, which continued until last night. The patient thinks the vomitus had a faecal odor and was dark yellow in color. He was unable to take food until 24 hours after vomiting. Abdominal pain began two days ago and was constant, not paroxysmal, throughout the whole right side. He places his hand to the right of the umbilicus and to the upper right quadrant of the abdomen. The bowels have moved daily three or four times and contain no blood. There was a free movement last night with flatus. He has had chills, one at 8 P. M. last evening and one at 2 A. M. this morning, followed by profuse sweating. The patient never had previous similar chills, and no trouble of the kind is known in his neighborhood. He drinks hydrant water. Temperature 103° F. Micturition normal.

Physical Examination.—Patient walks erect. He is large, well developed, of good color, skin moist, no jaundice, conjunctivæ clear. Tongue slightly coated. He complains of intense pain when head is touched. There is no cervical rigidity. Pupils react equally to light. He is rather

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excitable. Abdomen: symmetrical respiratory movements are present throughout the whole abdomen. Upon deep inspiration he complains of pain in the upper right quadrant. The urinary bladder is not distended. There is no dulness in the flanks. Liver dulness begins at the 6th rib in the mammillary line of the abdomen. Midway between the median line and the umbilicus, dulness proceeds 8 cm. below the costal margin. On palpation the left side of the abdomen is soft and there is no tenderness and no rigidity of the rectus muscle in its lower half. Above the umbilicus, however, the rectus is rigid and pressure causes the patient to wince. The lower part of the right rectus is also relaxed, but there is slight tenderness on deep pressure. In the right iliac fossa, as throughout the whole right abdomen, there is some tenderness with resistance on deep pressure. There is no muscular spasm in this region. As the upper right quadrant is approached, tenderness becomes more marked, rigidity greater, and just above the umbilicus pressure on the rectus causes the patient to cry out. Over the dull area there is definite muscle spasm and great rigidity of the muscles, and this spasm likewise extends to the rectus above the umbilicus and to the other abdominal muscles around the margin of the dull area. No definite mass can be felt beneath the area of muscle spasm. Tenderness extends into the right flank, but the percussion note is resonant. No tenderness exists in either lumbar region.

There are no signs of hernia. The genitalia are negative. Rectal examination shows no tenderness and no mass. Rectal temperature 104° F. Pulse 100 per minute. Respiration 34 per minute. Leucocytes 36,600.

Evening note, 9 P. M.: Patient has complained of pain in right side of the abdomen throughout the afternoon and says that he feels worse than upon admission. Temperature by mouth at 8 P. M., 105.8° F.; by rectum at present, 105.4° F. Pulse between 100-120 per minute. Leucocytes 7000. Patient looks worse. Face is flushed; skin hot; no nausea and no vomiting.

Abdomen.—Respiratory movements present. There is slight distension. Tenderness has increased throughout the right side and the area of muscle spasm has extended further down the rectus and also further downward and outward in the right abdomen. There is, however, no general tenderness or spasm. The area of dulness seems to have decreased (probably due to increased distension).

October 7. Patient's temperature is still high, between 103°-105° F. There is less pain and tenderness in the abdomen. Leucocytes 8000.

October 8. The patient seems more comfortable to-day. Leucocytes at 11 A. M., 8000; at 10 P. M., 16,000. Pulse 98-100. Temperature at 2 A. M., 100.5°; at 10 A. M., 103.5°. Gruber-Widal test, negative.

October 9. Abdomen looks normal. Peliomata striking. There is no special tenderness present. Abdominal walls are held tense, especially over region of the gall-bladder, so that it is difficult to palpate.

Leucocytes at 11 A. M., 20,600.

Leucocytes at 3 P. M. (before operation), 19,000.

Leucocytes at 5 P. M. (immediately after operation), 22,000.

Note by Dr. Mitchell at 3 P. M.: During the last 24 hours there has been a marked change in the patient's mental condition, more or less delirium having developed accompanied with mental dulness. He responds intelligently to questions, but seems much more stupid than on admission. Dr. Halsted saw the patient at 1 P. M. and advised operation. Percussion by Dr. Halsted showed the area of dulness to be exactly as it was upon admission. Otherwise there is little change since yesterday. The abdominal condition has cleared up markedly since admission, muscle spasm having disappeared, leaving only the dulness and a lessened degree of tenderness. The bowels have moved freely and unaccompanied by vomiting. Temperature has been irregular, but high.

Operation by Dr. Mitchell.—Exploratory laparotomy under Schleich's solution plus morphia gr. $\frac{1}{4}$. Demonstration of multiple abscesses in the liver. General anaesthesia. Rupture of abscesses on under surface of liver near the gall-bladder. Packing off with bismuth gauze. Appendix negative. Four abscesses opened and cultures taken. Iodoform gauze drain inserted. Partial closure with silver wire.

Under Schleich's solution an exploratory incision was made through the right rectus muscle. A little clear fluid was seen in the peritoneal cavity and cultures were made. General anaesthesia was induced for exploration, as great pain was caused by touching the liver or parietal peritoneum.

The area of dulness was found to be due to a large right lobe of the liver. The left lobe projected beyond the median line. The liver was large, its edges thin. The area of muscle spasm was indicated by an injected haemorrhagic condition of the parietal peritoneum. On the surface of the liver several abscesses were seen, measuring 1-3 cm. in diameter. One of these on the left lobe was fluctuant, its surface bright yellow. About it was some fibrin as in fibrinous peritonitis. In the right lobe were several other abscesses.

The liver was packed off and the abdominal cavity explored. The

appendix seemed normal. The intestines were pale and distended. There was nothing to suggest primary infection. In exploring the liver ducts, pus was seen escaping from the lower surface of the liver near the cystic duct, and was found to flow from an abscess on the under surface of the liver which had probably ruptured during manipulation. There were about two ounces of thin, foul, bright-yellow pus which was followed by yellow necrotic-looking material. The abscess cavity was packed with a piece of iodoform gauze to protect the intestines. The gall-bladder was not distended and contained no stones. Its ducts were not explored further but were probably patent, as the gall-bladder seemed to empty itself during manipulation.

Bismuth gauze packing was now placed around the lower surface of the liver and peritoneum above. The abscesses in the left lobe were incised and from three drams to one ounce of thin, foul, pale-yellow pus with flocculent necrotic masses evacuated from each. A clamp could be passed into the substance of the liver to a distance of 5-10 cm. The liver seemed as a whole very soft. A strip of iodoform gauze was placed in each abscess. No other abscesses were seen, but the finger could detect uneven places on the surface of the liver beneath the ribs.

The abdomen was partially closed with mattress sutures of silver wire in the muscle, and with subcutaneous silver wire sutures.

October 10. Patient has been fairly comfortable since operation. Temperature has ranged between 99° and 105°. This afternoon patient had a chill and temperature rose from 103.6° to 105°. Pulse 96 per minute. General condition about the same as before operation. Leucocytes at 11 A. M., 24,000; at 4 P. M., 8600.

October 11. 8.30 A. M., leucocytes 16,800; 5.30 P. M., leucocytes 21,000.

Patient was redressed; the dressings were soaked through with a sanguino-purulent discharge. Temperature has ranged from 102-104.6°. He has been drowsy, at times very restless and anxious to go home. Conjunctivae still yellow, and the skin over the whole body has a slight yellow tinge. Patient has constant thirst. He talks rationally at times, but more often is decidedly irrational.

October 12 and 13. Patient has grown weaker and this morning (October 13) can hardly be aroused. Temperature 102.8°. Pulse 120 and very weak. Respirations 52 per minute. Extremities are cold and cyanosed. Dyspnoea is quite marked. General condition much worse. The jaundice has increased. Tremor still very marked. Death at 3.30 P. M.

Autopsy No. 1608.—Pathological Report.—The autopsy was performed by Dr. Eugene Opie on October 13, 1900, at 8.30 P. M., the body having been dead five hours. An abstract only is given here.

Anatomical Diagnosis.—Multiple abscesses of liver, lungs and spleen. Jaundice. Localized fibrinous pleurisy. Enlargement and hyperaemia of portal and retroperitoneal lymph-glands. Laparotomy wound below right costal margin, packed with gauze and extending to the surface of the liver. Acute interstitial nephritis.

The body is that of a large, muscular man, 172 cm. in length. Rigor mortis is present. The skin of the entire body has a fairly deep yellow hue. Below the right costal margin is a linear incision longitudinally disposed into which pass a large number of gauze strips, separated from the edges of the wound by rubber protective. Subcutaneous fat is abundant.

Peritoneal Cavity.—It contains no excess of fluid. The general peritoneal surface is smooth. The gauze drains referred to pass, a few over the upper surface of the liver a short distance, the majority to the lower surface between the liver and the gall-bladder and colon with its mesentery, and are firmly adherent to the surfaces with which they are in contact. These tissue surfaces are dull and in places of a black color. Strips of gauze enter three small cavities in the liver.

The large intestine is considerably distended. The appendix lying in the right iliac fossa is free of any adhesions.

Thorax.—The pleural cavities contain no excess of fluid. The lungs are retracted after removal of the sternum. The pericardial cavity is normal.

The Lungs.—Left Lung.—In general the surface is smooth and of a mottled gray and black color. The pleura over the external surface of the lower lobe, near the posterior border, is dull and in places covered with a thin layer of fibrin. About the middle of this surface is a round projecting area about 3 cm. in diameter; its center is of a conspicuous bright-yellow color from which extend outward irregular anastomosing lines of the same color (distended lymphatics). About the yellow center is a wide area of a deep red color. On section, the tissue below the yellow and red surfaces is firm and consolidated. The yellow central portion is quite irregular in shape; at one point it has softened and there is a small cavity containing thin yellow fluid.

Near the basal edge of the lung are two smaller lesions similar in char-

acter to that just described, the larger about 1 cm. across; in neither has the bright yellow portion softened. The remainder of the lung is crepitant, dry on section, and slightly bile-stained. The bronchi contain a moderate amount of tenacious somewhat blood-stained mucus. The bronchial lymph-glands are slightly enlarged, soft and of a red-black color.

Right Lung.—This differs but little from the left. Over the external surface of the lower lobe near the posterior border, the surface is dull and covered in places with a small amount of fibrin. Near the basal edge is a lesion similar to that already described in the left lung. The central bright-yellow area, about 1.5 cm. across, is very irregular in shape and not softened. Irregular lines extend outward from it below the pleura. The lymphatic glands are larger, but resemble those of the left.

Liver.—Weight 4090 grm. The organ is of very large size. In general the surface is smooth, but is studded, particularly over the upper surface of the right lobe, by low boss-like projections whose center is a conspicuous bright-yellow color, about which is a wide irregular zone of very deep-red color. The surface between is of a deep-red tint but not so deep as that about the yellow areas.

The anterior third of the upper surface of the right lobe is in very large part occupied by bright-yellow areas often confluent, between which the surface is of a very deep-red color. On section through the projecting areas, one finds that they represent abscess cavities in the substance of the liver, surrounded by a zone of very deep injection. Though they vary very much in size (see Plate XLII), the usual diameter of the central yellow portion is about 2 cm.; the zone of injection varies greatly and is often continuous between adjacent cavities. A narrow, irregular, somewhat convoluted zone of solid bright opaque-yellow material surrounds a cavity containing thin, slightly turbid fluid. The formation of these abscesses appears to bear a definite relation to the liver lobulation. In the right lobe where abscess formation occupies a large proportion of the substance of the liver, in the hyperaemic tissue abutting upon the abscesses corresponding to the lobules are minute bright-yellow areas of opaque appearance, in the center of which is the section of a small vessel. These minute areas are separated by tissue of red color in which also on careful examination can be seen a vessel cut across or longitudinally. The yellow zone apparently increases in size, and other areas are made up of small rounded areas about 2 or 3 mm. across, composed of somewhat soft yellow tissue and separated by red lines. Finally the central portion of such a collection of small foci softens and the larger abscess cavities with irregular walls are thus apparently formed. In one part an abscess abutted upon and eroded a large branch of the hepatic vein.

In the relatively normal portions of the liver, lobulation is well marked; the tissue is bile-stained and greenish.

Gall-bladder.—The surface is rough, having been in contact with the gauze packing. The wall is somewhat thicker than usual. It contains translucent viscid bile. The gall-ducts are normal.

No abnormality of the hepatic artery or portal vein was discoverable. In the gastro-hepatic omentum are several lymphatic glands about 1 cm. in diameter, soft, succulent, and on section of a dull red color.

Spleen.—Weight 190 grm. Upon the anterior edge an opaque-yellow, slightly raised area, measuring 0.5 cm., occurs. This area on section proved to be an abscess surrounded by a deep-red zone of splenic tissue.

Intestines.—Duodenum and jejunum are normal. The lowermost 100 cm. of the ileum show well-marked injection of the blood-vessels, giving a red color which is most intense in the neighborhood of the ileo-caecal valve. Peyer's patches and solitary follicles are normal. Appendix and colon are normal.

Kidneys.—Combined weight 450 grm. The two organs resemble each other closely. The capsule comes away readily, leaving a smooth yellow-gray surface upon which can be seen minute red areas. The organs are firm in consistence. The cortex is 7 mm. thick, and is pale gray with a yellowish tinge (jaundice). Striae are visible. Malpighian bodies are conspicuous. The mucous membrane of the pelvis is stained yellow, and below, here and there, ecchymoses occur.

The splenic, superior mesenteric and portal veins when cut open show no abnormality.

Microscopical Examination of Hardened Tissues.—*Liver.*—There is a general dilatation of the capillaries with blood, more especially in and around the central vein, where the liver cells are swollen, hyaline, and without nuclei. There is a general leucocytosis present and occasionally can be seen small clumps of polymorphonuclear leucocytes, some of which show fragmentation or distortion of their nuclei. Large mononuclear cells are to be found here and there, resembling those described by Mallory as being present in the blood in typhoid fever. They evidently are phagocytic, as they contain nuclear protoplasm. In the capillaries certain material is met with at times which stains with haematoxylin and under the immersion lens is found to be composed of bacteria.

The chief lesions present are, however, smaller or larger areas of necrosis. If large, their outlines tend to be lobulated in character, and if small, they have a rounded appearance. These necrotic areas are made

up of three zones, (a) an outer, of varying width, which may occasionally be wanting, made up of polymorphonuclear leucocytes; (b) a middle zone, usually narrow, composed of irregular or round masses of small size, homogeneous and taking the haematoxylin stain, and under very high power these are seen to be made up of bacteria; (c) an inner or central zone consisting of necrotic liver cells and leucocytes whose outlines can only be indistinctly seen, and odd clumps of bacteria. This central zone stains intensely with eosin. Quite often the dead areas of one lobule fuse with those of others leading to the formation of large irregularly-shaped masses of necrotic liver substance.

As regards the anatomical origin of these necroses, it would seem that they arise close to the central vein (rarely within, unless by the lodgement of a bacterial thrombus), and at times in the middle third of a lobule. Now and then areas of necrosis are discovered apart from the presence of bacteria as far as can be seen in the sections.

Nowhere is there any appearance of repair, the process being an acute one.

Lung.—The section contains an abscess similar in character to the larger ones in the liver, namely, wide necrotic areas surrounded by a zone of polymorphonuclear leucocytic infiltration; leucocytes occupy alveoli. The surrounding tissue shows engorgement of blood-vessels and infiltration with red blood corpuscles. A bacterial thrombus is seen at one portion of the periphery of a vein.

Spleen.—The organ contains a similar abscess. The zone of necrosis is very wide and at the periphery there is an abundant blue staining material (bacteria?); the zone of leucocytes is very narrow. The pulp is distended with blood; the small vessels are dilated.

Kidneys.—In many small areas, particularly about the vessels between cortex and pyramid, are areas in which the interstitial tissue is infiltrated with round and plasma cells. The cells of the tubules are large, sharply outlined and granular.

Bacteriological Report of the Autopsy.—At the autopsy, plate cultures were made in plain agar from the blood of the heart, the liver, liver abscesses, spleen, kidney and peritoneal cavity. The plates were placed in the thermostat at 36.5° C., left for 24 hours and examined. All were found to be grossly contaminated by a variety of *B. subtilis*, due no doubt to imperfect previous sterilization of the plates. Later on, a second series of plates was made in both plain

and hydrocele-fluid agar from the abscesses in the liver, and grown aërobically and in a hydrogen atmosphere at 36.5° C. for 48 hours.

A rabbit was likewise inoculated intravenously with 0.4 cc. of the purulent content of one liver abscess.

The inoculated plates containing both media which were grown aërobically were sterile at the end of 48 hours. The anaërobic plates were not examined until the end of 72 hours when it was found that all the plain agar plates were sterile, while of those containing hydrocele-fluid agar, the first plate alone gave three foci of growth.

Description of the Colonies.—Arising from each of the three small shreds of necrotic tissue could be seen a small zone, about 5 mm. in diameter, of minute white colonies, wholly lying in the depths of the medium.

These zones were found on weak magnification to be made up of more or less oval and round colonies presenting a finely broken-glass appearance. In color they were light brown-yellow, and they were translucent and quite smooth in contour.

Cover-slip Preparations.—Stained preparations showed the colonies to be made up of bacilli, small but variable in length and thickness and having rounded ends. They occur singly, in pairs and in short chains, the latter often resembling streptococci. Treated by Gram's method they become decolorized, and no spores were discovered. From the plates, plain and hydrocele-fluid agar tubes were inoculated and grown in air and in an atmosphere of hydrogen. Colonies developed in the latter tubes kept anaërobically which showed on cover-slips bacilli identical in morphology with those present in the contents of the liver abscess. The bacilli stain readily in carbol-fuchsin and aniline gentian violet.

Bacterioscopic Examination of Contents of Liver and Spleen Abscesses.—*Liver.*—Considerable numbers of polymorphonuclear and mononuclear leucocytes were present amongst which vast numbers of bacteria were scattered. Apparently one type of bacteria only occurred, which was of a rod form for the most part, although coccus-like forms have been noted. The bacilli varied in length, less so in breadth; some seemed almost the size of typhoid bacilli, whilst the

majority were much more minute. Occasionally one saw forms with slightly swollen ends, which at times stained heavily; more rarely, short filamentous forms were to be seen, and also curved rods. No spores were noticed, although beaded appearances were often seen, resembling *B. tuberculosis*. Appearances suggestive of branching were noted at rare intervals. The organisms decolorized quite readily by Gram's method of staining and were devoid of spores.

Spleen.—Owing to possible over-heating during fixation, the organisms, which were present in countless numbers, stained poorly and were swollen and slightly refractile. In consequence they were coarser in appearance than those from the liver abscess and more definite and numerous coccus-like forms appeared.

Fresh pus diluted with Dunham's solution was examined as a hanging drop. No independent motility could be observed, but brownian movement was active.

Study of the Bacillus in Pure Culture.—Since it was found that the organism was not able to grow upon any of the ordinary culture media except when human blood or serum were present, placental blood or hydrocele-fluid was added to such media when possible, and the cultural characters of the bacillus studied under those conditions. To avoid the danger of working with mixed cultures from the original plate, the organisms obtained from that source were at once plated both in plain and hydrocele-fluid agar and brought under aërobic and anaërobic conditions for 72 hours at 36.5° C. At the end of that period no growth whatsoever was obtained in the aërobic plates, while multiplications occurred only on the anaërobic hydrocele-fluid agar cultures.

Appearance of Colonies.—To the naked eye all the surface colonies presented the appearances of small colon bacillus colonies, being about 1-2 mm. in diameter. Under the microscope the surface colonies were yellow-brown, coarsely granular, somewhat reticulated, nucleated, rather thick at centers, delicately fringed, translucent and with regular peripheries. The deep colonies were small, oval, round, triangular or irregular in shape, dark-brown in color, granular and translucent. The odor of plates was decidedly and offensively faecal.

Morphology.—The form of the organisms proved to be identical with those obtained from the pus of the abscesses and the original plate culture.

Subcultures were made as before and only those were positive which were made on hydrocele-fluid agar and grown either in a hydrogen atmosphere or according to the method of Buchner. It was noted that growth was equally good and rapid whether incubated in hydrogen or in an atmosphere from which the oxygen had been absorbed by alkaline pyrogallie acid.

Depending upon the density of the agar, variations in appearance of colonies could be obtained. If the agar were thin, it was noted that a deep colony would be surrounded by a swarm of much smaller ones. This effect was less noticeable in surface colonies, but if the agar was denser no such radiating effect took place.

The general cultural characters of the bacillus are set down in Table I.

Further Biological Characters of the Bacillus.—Although a complete study of all the biological characters of the bacillus could not be carried out, certain observations were made which deserve to be mentioned.

Viability.—One plate culture sixteen days old was no longer capable of transplantation, but, as a rule, it was found that most colonies on other plates died out at the end of a week. Tube cultures gave better results under certain conditions. It was found that deep stab cultures lived much longer than streak cultures, that is, when both were left exposed to the air after growing 48 hours in hydrogen. For example, one stab culture was found viable at the end of 42 days, another at 21 days, but of four tubes 16 days old, only one gave positive results on subculture. Streak cultures had usually short lives; of two cultures three days old, one only survived, but another culture four days old still gave subcultures. It would have been interesting had these experiments been made under continuous exposure to hydrogen, as the comparison between deep stab cultures and streak cultures when kept exposed to the air, showed such great difference in length of viability that it seems probable that the oxy-

TABLE I.

Medium.	48 hours at 37° C.	72 hours at 37° C.	6th day (room temp.)
Hydrocele-fluid agar (slant and stab).....	Along line of inoculation are seen a few scattered, elevated, semi-opaque, gray-white, moist, smooth, round, glossy cols., measuring 1-2 mm. in diameter. Stab growth is vigorous, white, granular, and translucent. There are many gas bubbles in the medium and condens. water is cloudy and has a precipitate.	Unaltered.	Unaltered.
Hydrocele-fluid glucose agar (stab).....	Gas formation vigorous. Surface is covered by a heavy condensation-water growth. Stab growth is vigorous, whitish, granular and broken up, by bubbles of gas. Some growth is seen in gas bubble clefts.	More gas formation. Growth everywhere more decided.	Most gas is now absorbed, and growth is seen in the gas clefts.
Glycerine agar (plain)...	No growth.	No growth.	No growth.
Potato (streaked with hydrocele-fluid)	No visible growth. Cover-slip preparations show no increase.	Idem.	Idem.
Bouillon + hydrocele- fluid	Uniformly and faintly cloudy. No scum on surface. An abundant semi-viscid, flocculent, whitish ppt., which on shaking vigorously diffuses with great difficulty, rising up string-like, $\frac{3}{4}$ the way to surface and then breaking up.	Slightly more cloudy. A froth is seen on surface and gas bubbles are seen rising. Odor faecal.	Less cloudy. The ppt. has increased somewhat.

Litmus milk + hydrocele-fluid.....	General reaction slightly acid. The cream-ring has a greenish-blue tint. No coagulation, but an appearance as if medium were beginning to clear up.	Slight increase in acidity. No coagulation; same appearance as if peptonizing.	There has occurred a total solution of casein, and medium is now almost transparent and of a dark red-purple color.
Ox blood serum	No growth.	No growth.	No growth.
Gelatine + hydrocele-fluid (shake culture)...			No liquefaction. Large numbers of small, round, white, opaque colonies. No gas bubbles seen.
Human blood glucose agar.....	Gas formation moderate in amount. Growth occurs all way down stab. Odor disagreeably aromatic.		Has been further gas formation as shown by increased number of now empty gas clefts filled with growth. Color of haemoglobin brown.
Bouillon + blood.....	Faintly and uniformly cloudy. It has a froth on surface and small gas bubbles can be seen rising. There is a white semi-viscid ppt. which diffuses with great difficulty.		Froth has gone. Haemoglobin color lost and replaced by a light dirty brown. Medium more cloudy than before.
Litmus milk + blood...	Acid reaction moderate. No coagulation.		Reaction unaltered. No coagulation, no peptonization. Color of haemoglobin has nearly been lost.
Dunham's solution + blood	Very faintly clouded. Has a small amount of white, semi-flocculent, semi-viscid ppt. which diffuses with difficulty.		Still faintly cloudy. The haemoglobin color is still a rich cherry-red. The ppt. has increased in amount.

Motility, negative. Gram, negative. Indol, trace. Spore-formation, not observed in any medium.

gen of the air exerted no feeble bactericidal influence upon the bacilli.

The organism, too, finally developed a tendency towards reproductive enfeeblement, as subculture succeeded subculture, so that it became more and more difficult to induce it to grow, and, at last, it died out at the twenty-third generation.

Thermal Death-Point.—The tests were carried out with a vigorous hydrocele-fluid broth culture three days old, by introducing small quantities into small Sternberg bulbs and enclosing the bulb in a fine-mesh wire box, immersing it completely in water at a given temperature and constantly keeping it moving, at the same time carefully keeping the temperature even. After exposure, the contents of the bulb were expelled into tubes of hydrocele-fluid agar and plated, then incubated for four days in hydrogen at 36.5° C. A control from the broth culture was also made subject to the same technique, excepting, of course, any exposure to heat beyond that required to expel the contents from the bulb. The results were as follows:

Exposure.	Result.
5 minutes at 50° C.....	= Positive, 15 colonies.
5 " " 55°	} = Negative.
5 " " 60°	
5 " " 65°	
10 " " 50°	
10 " " 55°	} = Innumerable colonies.
Control.....	

Hence, a five-minute exposure at 55° C. was regarded as the thermal death-point of the bacillus.

Toxin Production.—An attempt was made to determine whether the organism yielded soluble toxins or not. To this end, 550 cc. of dextrose-free broth, made according to the directions of Theobald Smith, of a reaction of .5 +, were mixed with 185 cc. of hydrocele fluid under aseptic precautions and poured into a Fernbach flask and incubated for 48 hours at 36.5° C. Being found sterile the fluid was now inoculated by emptying into it the whole of a hydrocele-agar

culture of the bacillus obtained from the liver of Rabbit VI. Hydrogen gas was then passed through the flask for three-quarters of an hour and the flask was placed in the thermostat. At the end of 24 hours the growth was tolerably abundant, and upon the fourth day it was very heavy, appearing as a slimy, gray-white layer on the bottom of the flask and clouding moderately and diffusely the supernatant fluid. When thirteen days old the culture was filtered through a Pasteur-Chamberland filter. The filtrate was found upon titrating a portion to have a reaction of 0.85 +, being an increase in acidity of 0.35. A rabbit was given 1 cc. of this filtrate intravenously, and during a period of sixteen days during which it was under my own observation the animal showed no symptoms. Twelve days later the animal was found dead, but owing to the carelessness of an attendant its death was not reported. It would appear from this experiment that no active soluble toxin was produced.

Production of Sulphides.—During the attempt to find a soluble toxin it was thought best to renew the anaërobic condition in the flask by passing fresh hydrogen through the culture. As soon as an opening was made a most foul-smelling outrush of gas occurred, and so powerful was the stench that it could be easily detected throughout the building in which the experiment was being carried on. Suspecting the existence of sulphides, a test was made for their presence in the escaping gas, and a piece of filter paper soaked in a weak aqueous solution of lead acetate was very quickly turned a deep brown color, thus giving positive evidence of their presence. As a control to this a similar piece of paper was held in the stream of hydrogen from the generator for two minutes without showing the least trace of discoloration. When filtered, the filtrate gave no evidence of sulphides in solution when lead acetate paper was soaked in it. The gas collected in fermentation tubes also gave positive tests for sulphides, the atmosphere of the culture having been nitrogen.

Fermentation.—Having previously noted the constant appearance of gas in hydrocele-fluid agar made up with dextrose-free broth, an attempt was made to find out how active this fermentation might be, and what was the composition of the gas. Three fermentation tubes

were filled with hydrocele-bouillon whose reaction was 0.1 +, and inoculated with the organism from an active culture, and incubated four days in a Buchner jar. In each tube 1 cm. of the upper part of the branch was occupied by gas, whose composition when roughly estimated was $\frac{3\text{H}}{1\text{CO}}$ although with this was mixed a gaseous sulphide, presumably hydrogen sulphide, as shown by lead acetate paper. What was the fermentescible substance present in the bouillon? As the sugar, it was believed, has been quite removed from the meat extract by previous fermentation with *B. coli*, it seems not unreasonable to consider that the gas was produced from proteid, especially as it was sulphur-containing. An analogous condition is seen in the abundant gas formation in dextrose-free broth by the action of *Bacillus aerogenes capsulatus*.

It might be mentioned that egg-cultures could not be obtained, although twice attempted.

Optimum titre of media.—Several tests were made and it was found that the degree of acidity recommended by the Bacteriological Committee of the American Public Health Association, namely, 1.5, was too great and a growth was difficult to obtain in a medium of that reaction, while the organism flourished most vigorously in media between 0.5 and 0.1 acid.

Animal Inoculations.—As previously stated, a rabbit was inoculated intravenously with 0.4 cc. of pus from one of the abscesses in the liver of the human cadaver. This animal died in seventeen hours and showed no naked-eye lesions, and cultures from it were negative; yet the histological examination of the liver showed interesting changes which will be mentioned later on.

With pure cultures of the bacillus further inoculations were carried out upon rabbits, guinea-pigs and mice with results which practically reproduced in many of the animals the hepatic lesions found in the human case, the organism seeming to exercise a selective action upon the liver when introduced into the blood directly or through the abdominal cavity. The results of this series of inoculations are given in the following table:

TABLE II.

Animal.	Date of inoculation.	Material used.	Quantity of same.	How inoculated.	Results.	Cultures (Pos. or neg.)	Length of time taken to kill.
Rabbit I.	Oct. 23rd.	Pus from liver abscess of cadaver.	0.4 cc.	Intravenously.	Died, Oct. 24th.	-	17 hours.
Rabbit II.	Oct. 25th.	Condens.-water of growth from a 3 day-old agar slant, from col. "B." (Gen. 3rd).	0.5 cc.	Intravenously.	Died, Oct. 31st.	+	6 days.
Rabbit III.	Oct. 25th.	Ditto, from col. "A"—3 days old. (Gen. 3rd).	0.3 cc.	Into liver through thoracic wall.	Died, Nov. 6th.	+	12 days.
Rabbit IV.	Nov. 4th.	Condens.-water growth on agar 4 days old, from perit. cav. Rabbit II.	0.25 cc.	Intravenously.	Died, Nov. 10th.	+	6 days.
Rabbit V.	Nov. 4th.	(Ditto).	1 cc.	Subcutaneously.	Died, Dec. 3rd.	-	29 days.
Rabbit VI.	Nov. 11th.	Perit. fluid from Rabbit IV.	1 cc.	Intravenously.	Died, Nov. 16th.	+	5 days.
Rabbit VII.	Nov. 27th.	Condens.-water growth on agar 13 days old, from Rabbit II.	1 cc.	Intravenously.	Died, Dec. 5th.	-	8 days.
Rabbit VIII.	Dec. 5th.	Toxin, 13 days old.	1 cc.	Intravenously.	Died, Jan. 2nd, 1901.	..	28 days.
Rabbit IX.	Dec. 13th.	Bouillon cult. 3 days old.	0.75 cc.	Intravenously.	Died.	-	20 days (?)
Guinea-pig I.	Oct. 25th.	Condens.-water growth on agar 3 days old, from col. "C." (Gen. 3rd.)	0.5 cc.	Intraperitoneally.	Died, Dec. 13th.	-	49 days.
Guinea-pig II.	Nov. 4th.	Condens.-water growth on agar 4 days old, from perit. cav. Rabbit II.	0.5 cc.	Intraperitoneally.	Died, Nov. 8th.	+	4 days.
Guinea-pig III.	Nov. 18th.	Ditto, 2 days old, from liver of Rabbit VI.	0.5 cc.	Intraperitoneally.	Died, Nov. 20th.	+	2 days.
Mouse I.	Oct. 25th.	Ditto, 3 days old, col. "B." (Gen. 3rd).	0.3 cc.	Subcutaneously.	Died, Nov. 6th.	+	11 days.

The gross pathological appearances following upon the inoculation of the animals were so uniform that it seems preferable to give a composite description of the results, rather than to enter into the details found in each animal. Due mention will, of course, be made of any peculiar conditions existing.

After intravenous and intraperitoneal inoculations in rabbits there was rapid emaciation. The chief pathological effects, however, were noted in the peritoneum, liver and spleen.

The peritoneal cavity showed in some cases an acute fibrino-purulent or sero-fibrino-purulent inflammation. The small and great intestines were glued together and attached to the liver, stomach and spleen by fibrinous adhesions, while at times a collection of blood-stained turbid fluid, in which floated small masses of coagulated lymph, appeared in the dependent parts. The vessels of the peritoneum everywhere were deeply injected, but the glossy character of the tissue was rarely lost.

The surfaces of the liver were almost regularly covered by a layer of yellowish-white fibrin which caused the organ to adhere closely to the diaphragm, and the various lobes to one another. On removing this exudate the liver substance was seen to be irregularly studded with yellowish-white, roundish areas which stood out prominently in the dark chocolate coloring of the relatively normal tissue. These areas varied in size from 0.25-0.3 mm. and at times protruded above the general level. On section of the organ it was found that the contents of these foci consisted of a cheesy material. There was no definite zone of inflammation surrounding them, but at times a delicate grayish capsule more resistant to invasion could be seen limiting the larger abscesses. The relatively unaltered liver tissue was softer and much more friable than normal and the lobulations could be made out with difficulty. The gall-bladder was unaffected and usually contained a dark green-colored bile.

Abscesses were absent in the spleen and the organ was enlarged, brown-red in color, soft and friable, and more or less sheathed in exudate which caused it to adhere to the intestines or costal wall.

One rare lesion was that of thrombosis of a splenic vessel causing infarction of the whole spleen, which then was pale red-brown or salmon color, enlarged, firm, and on section, of a homogeneous and dry appearance.

In two instances the adrenal glands were enlarged and pale and oedematous looking. On section, they showed an almost homogeneous structure and were quite moist; no pigmentary layer could be discerned.

In Rabbit No. III the duodenum contained an abscess within its walls about 5 mm. in diameter. Rabbit No. IV showed many small opaque white areas in the walls of the appendix and in the small gut.

In one case (Rabbit No. III) the stomach contained within its walls towards the pyloric end an abscess measuring 0.5 cm. in diameter.

The pleural and pericardial cavities usually contained a very little clear fluid.

The muscle of the heart was pale. In one case only (Rabbit No. II) was any gross lesion noted, and in this there occurred in the walls of the left ventricle and septum ventriculorum a number of small, opaque-white foci measuring 0.25 to 1 mm. in diameter.

In only one animal (Rabbit No. II) were any foci of necrosis found in the brain. This animal showed in both lobes of brain several round opaque-white areas measuring about 2.5 mm. in diameter.

Subcutaneous inoculation of a rabbit was followed in two days by inflammation of an exudative character. Examination on the fourth day showed a tumor beneath the skin averaging 2.5 cm. in extent. The tumor felt tense and was slightly yielding, and the skin over it was reddened. The animal gradually lost flesh but had a good appetite, and the tumor slowly increased in volume and became firm until upon the 18th day it discharged a considerable part of its contents through the skin having become ulcerated. The exuded material was very thick, its color a yellowish-white and without foul odor. Cultures made from this material were negative, and cover-

slips showed nothing amongst the debris which could be said to be organisms. The abscess continued to discharge and more skin over the upper portions sloughed off, leaving a raw surface 3 x 4 cm. which scabbed over, whilst the lower part of the tumor remained prominent and unaltered. The animal grew more emaciated and weak, the scab became detached, and upon the 30th day the animal was found dead. The autopsy showed the existence of a granulating wound corresponding to the slough mentioned. In the axillary region were two round masses the size of hazel-nuts of a somewhat lobulated character, rubber-like consistence and covered by a thin capsule of fibrous tissue. The contents were yellowish-white and of the consistence of stiff putty. There were no signs of peritonitis; the spleen was not enlarged, but was dark red in color and of soft consistence. The liver showed a few small coecidial nodules, its color was slightly darker than usual and its consistence reduced. Everywhere throughout the organ were seen very many small opaque whitish areas, the largest being about 1 mm. in diameter; cover-slips from these areas showed no bacteria.

Cultures from the liver and spleen yielded *B. proteus vulgaris* and from the caseous subcutaneous nodule and spleen a diplococcus; none of the typical bacilli were found. These organisms found must probably be regarded as secondary invaders, having possibly entered through the skin lesion.

Guinea-pigs are somewhat less susceptible to inoculation with the bacillus. One of these animals lived 49 days and showed, at autopsy, chronic peritoneal adhesions consisting of firm bands of fibrous tissue which united most of the viscera. A second animal showed necrotic lesions of the lungs. The usual lesions met with in rabbits were also encountered in guinea-pigs.

The effect upon mice was imperfectly studied. One mouse was given a subcutaneous injection of the organism and survived 11 days. The only lesion discovered at autopsy was an abscess at the site of inoculation containing yellow-white cheesy material. Strange to say, this animal, of all inoculated in this study, was the only one in

which the bacillus was recovered from the general circulation. The second mouse inoculated succumbed early to a secondary infection.

Pathological Histology.—The microscopic examination of the experimental lesions showed an almost exact reproduction of the appearances given in the description of the material from the human subject; hence this description will be confined to appearances which were not present in the diseased tissues of the original case and to such which in the animals were more severe than were met with in the human tissue.

Liver.—Rabbit No. I, inoculated intravenously with 0.4 cc. of the pus from an abscess in the liver of the human cadaver; dead in 17 hours. The lesions are early and entirely microscopic. They are confined to the outer or middle zones of many of the lobules and consist of round, densely packed masses of polymorphonuclear leucocytes, among which in rare instances can be found minute masses of bacteria. The liver cells have been utterly destroyed where these foci exist and no trace of them can be found. Contiguous to these or even at some distance from them are irregularly shaped areas of hyaline necrosis of liver cells which take the eosin stain strongly. The nuclei of the hyaline cells may be entirely gone or reduced to bodies faintly staining with haematoxylin, while the endothelial cells of the capillaries show in places karyorrhexis, and may even be obliterated. The hyaline necroses are confined to the outer and middle zones of the lobules. Nothing definite was made out as to their origin. The hyaline areas are free from leucocytic infiltration, excepting that which is general throughout the blood capillaries.

In the case of the subcutaneous inoculation (Rabbit No. V) the lesions are conceivably due to toxin action alone, since no abscesses or bacterial foci could be found anywhere, the disease being limited for a long period to the subcutaneous tissues and axillary glands only. The liver of this animal shows coagulative necrosis in which, in some instances, the cells present a fibroid appearance and in others are shrunken or have disappeared. In the latter conditions there is an accompanying infiltration of phagocytic cells, which themselves

occasionally become necrotic, possibly through toxin activity. Exceptionally, such a focal necrosis is quite replaced by mononuclear leucocytes, in which case the picture recalls that of the so-called lymphoma of the human liver in typhoid fever. Occasionally a definite ingrowth of the connective tissue of Glisson's capsule can be seen between some of the lobules, nipping off and destroying parenchymatous cells.

The most interesting materials for study were derived from Rabbits No. III and No. IV (see Table II). These animals showed the typical abscesses, and in addition an overgrowth of the connective tissue cells of Glisson's capsule which invaded the lobules and ultimately destroyed them, as can be noticed upon tracing the course of events throughout the specimen as a whole. The picture is very like that seen in intralobular cirrhosis in man, except for the fact that the process here is not so general in its distribution, but is confined largely to the neighborhood of the abscesses. The intestinal lesions of Rabbit No. IV were found to be localized in the lymph nodes of the submucosa, which had undergone coagulative necrosis. Bacteria were not found in the intestinal lesions, and it would therefore appear as if the process were due to absorption of toxic products from the acutely inflamed serosa.

The spleen of Rabbit No. II is the seat of anaemic infarction, due to the large and important splenic vessels having become thrombosed. The spleen was also embedded in a thick envelope of newly formed connective tissue, rich in blood-vessels, plasma cells and in small mononuclear lymphocytes. In this connective tissue sheath lies a vein of moderate size containing a well-developed platelet thrombus hanging free in the lumen and completely encircled with a layer of endothelium. To one side of the thrombus, a freshly-formed mass of platelets and leucocytes anchors it to the wall of the vein, doubtless the free-hanging end of the main mass being further down in the vessel.

Rabbit II also presented some features which were not met with either in the human subject or in any of the other experimental

animals, namely, abscess formation in the cardiac muscle and in the cerebral hemispheres. In the heart wall three areas were discovered which showed some slight variation in character. One presented a relatively large central zone of coagulation necrosis with good preservation of the general architecture of the muscle fibers but loss of minute detail of structure. The middle zone consisted of a narrow band which stains deeply in haematoxylin and is made up largely of dense masses of bacteria and disrupted cell nuclei. There are very few leucocytes found in this zone. The outer zone, also narrow, is made up of muscle cells which have undergone hyaline degeneration with loss of their nuclei, and which are under considerable pressure from the growing mass within. Beyond these zones the muscle fibers are relatively widely separated, possibly due to local oedema, while the fixed connective cells are swollen and proliferating in places. The other two foci are probably an earlier stage than the foregoing, and only two zones are present: an outer narrow one of hyaline transformation, and an inner larger one of bacteria, degenerated leucocytes and other cellular elements, but in which no definite muscle structure is to be seen. The small blood and lymph vessels in the neighborhood show distinct evidences of a local leucocytosis, although there is no massing of the cells in close relation to the destructive process. The leucocytes are very sparingly and evenly distributed in the area of local oedema.

The brain lesion is marked by a most extensive coagulation necrosis, in which a few polymorphonuclear leucocytes can be seen in stages of disintegration. Bounding this necrotic focus is a more or less complete zone of dense leucocytic infiltration, consisting chiefly of polynuclear cells, although some mononuclear cells are also present. The lymphatic channels of the pia mater near to the lesion are crowded with white blood-corpuscles, while the blood-vessels of the pia and surrounding cerebral tissue show a greater number of leucocytes than are normally present. The bacteria are found around the periphery of the necrotic zone, for the most part in dense agglomerated masses.

Comparison with Species Already Described.—Aside from the anaërobic bacteria producing tetanus, quarter-evil, botulism, malignant oedema and emphysematous gangrene, with which the organism described in this article clearly has little in common, we shall turn for comparison to the published descriptions of the bacteria concerned in the production of gangrene and fetid abscesses connected with the genito-urinary tract, the intestinal tract, the middle-ear, the cranial cavity, and other portions of the body, to determine whether *Bacillus mortiferus* is or is not a new species.

Veillon and Zuber have described a considerable number of bacterial species, which were isolated in dextrose agar after the method of Liborius and consisted of bacilli, micrococci and spirilla. A brief description of the various bacillary species will now be given.

Bacillus ramosus (Veillon and Zuber) is a small, slender bacillus which is slightly larger than the bacillus of mouse-septicaemia when found in the smears made from the pus or other exudates; but when examined from cultures the bacillus appears in short chains, forming pairs like the letter V, and in pseudo-filaments, and in forms which show irregular swollen contours, resembling somewhat *Bacillus diphtheriae*. Moreover, according to Guillemot, the bacillus is often branched. It does not form spores, is non-motile, and it stains irregularly by Gram's method. The optimum temperature of growth is 37° C., and no growth was obtained on gelatin at room temperature. On glucose agar the colonies resemble *Streptococcus pyogenes* but are finer and more transparent. Sugar-bouillon becomes clouded and exhibits a slight whitish precipitate, with a varying amount of gas production. A fetid odor is given off by all cultures. Growth takes place vigorously in hydrogen and the bacillus lives about one month in cultures. The bacillus is pathogenic for the mouse, rabbit and guinea-pig upon subcutaneous inoculation, following which, well-defined abscesses occur leading to the death of the animals from cachexia in about a week, and after intravenous injection of the rabbit an intoxication only results, no lesions having been found anywhere in the body.

Bacillus fragilis (Veillon and Zuber).—This organism is much smaller than the preceding. It is, as a rule, straight, but occasionally is curved. The ends are rounded, and sometimes, on account of the center taking the stains less deeply than the poles, it resembles a diplococcus. In pus it is often difficult to find because the debris takes the stain along with

the bacillus; it does not stain by Gram's method and no spores are formed, although certain swollen short forms of the organism may be mistaken for them. The organism grows in both agar and gelatin at room temperature and does not liquefy the gelatin. The optimum of growth, however, is that of the thermostat. In sugar broth the growth is relatively abundant and no gas is formed; but in glucose agar a small amount of gas becomes evident, although it is insufficient to break up the jelly. Its odor is fetid. Duration of life in cultures is variable; occasionally it lives for 25 days. The bacillus is pathogenic when inoculated subcutaneously in guinea-pigs, causing abscesses which produce death in about eight days. It is much more pathogenic for rabbits, causing large abscesses which slough through the skin, the animals dying in seven or eight days. Inoculated in the veins, these animals die from a cachexia and the bacilli are not recoverable in cultures.

Bacillus fusiformis (Veillon and Zuber). As seen in pus this bacillus is a fusiform rod with pointed ends, occurring often in pairs. In cultures it preserves largely these characteristics, and in addition elongated, swollen and granular involution forms appear. The bacillus is non-motile, stains poorly with the ordinary dyes and not at all by Gram's method. It grows at room and body temperatures. Gelatin is not liquefied; very little foul gas is formed; broth is rapidly and strongly clouded; the colonies on agar resemble those of *B. coli* only they are more transparent. The viability lasts only four or five days. The bacillus is pathogenic for the rabbit and the guinea-pig, causing upon subcutaneous inoculation small abscesses without producing death.

Bacillus furcosus (Veillon and Zuber).—A very small bacillus of peculiar shape, dividing at one end into two branches like the Greek letter γ . In cultures the rods are longer and the ends of the branches become swollen into round or pyriform shaped bodies. The bacillus is non-motile, stains well with the usual dyes but not by Gram's method, does not grow at room temperature, and requires three or four days to produce visible growth at 37° C. The colonies on the surface of agar resemble those of the pneumococcus. In broth the bacillus forms a fine precipitate and some gas, which has a sour and fetid odor. The organism lives in cultures about twenty days. It is pathogenic for guinea-pigs, producing abscesses upon subcutaneous inoculation, without as a rule causing death. Occasionally they die after the lapse of several weeks from cachexia.

Bacillus serpens (Veillon and Zuber).—Somewhat larger than *Bacillus fragilis*; it stains with the ordinary dyes, at times the center staining

less readily than the ends, whereby an appearance of spores is given. In fact, spores are not formed. The bacillus decolorizes by Gram's method of staining. It grows in the various culture media, but not invariably, as pairs, pseudo-filaments, and short chains. It has, according to Guillemot, an undulatory or serpentine motion in gelatin cultures, which it renders fluid. The optimum temperature for growth is 37° C., but it slowly multiplies at room temperature. The colonies on the surface of glucose agar resemble those of the pneumococcus. Sugar broth is rapidly clouded and a heavy whitish precipitate forms at the bottom of the tube, leaving the medium clear. In a liquefied gelatin stab culture the deposit of a white flocculent sediment takes place, leaving the fluid clear. Fetid gas is formed in small amount in gelatin and agar. Viability extends to twenty or twenty-five days. The bacillus is less pathogenic for mice, rabbits and guinea-pigs than *Bacillus ramosus*.

Bacillus funduliformis (Hallé).—This bacillus was found in the vagina in normal and pathological conditions, and in other localities. It is a small, usually curved rod with rounded ends. Cultures often show pleomorphic forms appearing as large swollen rods, curved tortuous branching filaments or ball-like masses. In exudates the bacillus occurs chiefly within the pus cells as masses or as disseminated organisms. It does not stain readily with the ordinary dyes, and decolorizes by Gram's method of staining. Its optimum growth is at 37° C., at which temperature about six days are required for it to become very noticeable. It forms gas in sugar media which has a very fetid odor. When grown in broth in a vacuum it clouds the medium slightly at the end of the third day, but by the tenth day the bouillon becomes almost clear. The odor is quite foul. Rabbits are insusceptible, while subcutaneous inoculation of guinea-pigs gives rise to abscesses which at times become gangrenous; introduced into the peritoneal cavity of guinea-pigs no action is noticeable, and in no case did any of the animals succumb.

Bacillus nebulosis (Hallé).—A small bacillus resembling the bacillus of mouse-septicaemia. Usually straight, it curves occasionally or appears as a rod swollen at the center and tapering at the extremities. It decolorizes by Gram's method, is asporogenous, and shows no involution forms. Growth at 37° C. is slow and no growth is obtained at room temperature. No gas is formed in sugar media. It is inconstant in its pathogenic properties, as it produces abscesses in rabbits and guinea-pigs occasionally. It caused the death of one rabbit.

Bacillus caducus (Hallé).—Incompletely studied. A small bacillus which stains deeply by Gram's method and exhibits no pleomorphism. It survives in cultures three or four days.

Bacillus radiiformis (Rist and Guillemot).—An organism closely related to *Bacillus serpens* in all its characters; possibly identical.

Bacillus thetoides (Rist and Guillemot).—Closely related to or identical with *Bacillus funduliformis*.

Unnamed species.—According to Rist, Veillon and Zuber previously described two bacilli under the heads of species "A" and "C." The former is a long, slender, poorly-staining, Gram-negative bacillus. It does not grow in gelatin at room temperature, but grows in bouillon at 37° C. without clouding, forming small flocculi and giving off a fetid odor. It forms no gas in any of the sugar media. Injected into guinea-pigs and rabbits subcutaneously it forms small abscesses but does not kill.

Species "C" is a non-motile bacillus resembling the bacillus of chicken cholera. It appears not to grow in chains, but in sugar agar long and filamentous forms with round or fusiform swellings are noticeable. Bouillon is not clouded, growth occurring in small flocculent masses which collect at the bottom of the tube. All cultures have a fetid odor suggesting decaying cauliflower. The bacillus is destroyed by moist heat in one hour at 53° C. The pathogenic properties of the bacillus are manifested upon subcutaneous inoculation of mice, guinea-pigs and rabbits by the formation of abscesses which have a fetid smell. Mice and guinea-pigs survive the inoculations, but a rabbit succumbed after severe reaction. The bacilli were recovered from the local lesions and, in the rabbit, from the heart's blood. Rist encountered both these species and thinks that the latter organism may be identical with *Bacillus funduliformis* of Hallé.

Guillemot partially describes another species which, being as yet incompletely studied, he terms species "A." It is a small rod about the size of *Bacillus ramosus* but slightly shorter and in cultures is distinguished by forming chains. At the center of the units of a chain one finds a swelling of a round or fusiform shape, which is not of the nature of a spore. The surface colonies on glucose agar are like those of the pneumococcus. Bouillon is not clouded, but forms flocculi which settle at the bottom of the tube.

Cottet, in addition to finding many of the foregoing bacilli, describes three more which he believes to be new. They have not been named by him and are, in consequence, designated by the letters B, C and D. *Bacillus* "B" is described as being rectilinear, slightly swollen in the middle, tapering at the ends, occurring occasionally in chains of six to twenty units, and rarely in filaments. It is non-motile and decolorizes by Gram's method. It does not grow in gelatin at room temperature.

No mention is made regarding gas production. Cultures survive six weeks. The organism is pathogenic for guinea-pigs, in which upon subcutaneous inoculation it produces abscesses. Bacillus "C" is a regular, slender strepto-bacillus, the chains of which consist of 10 to 15 units. The bacillus is non-motile and stains by Gram's method. A complete study of the bacillus was prevented by its having died early in cultures. Bacillus "D" is a moderately sized, non-motile bacillus with rounded ends, staining poorly with ordinary dyes and decolorizing by Gram's method. It survived in mixed cultures for a long time, but not having been obtained pure, it was not completely investigated.

A comparison of the above series of bacilli with the species described in this paper, as *Bacillus mortiferus*, leaves no doubt of the fact that the latter organism differs widely from them all. Among the striking differences are the extremely selective character of *Bacillus mortiferus*, which requires a medium for its growth containing human blood or serum, its more energetic gas production, and its greater and peculiar pathogenic qualities.

Summary.—From a case of hepatic abscess in man a strictly anaërobic bacillus was obtained in pure culture which is not to be identified with any species of pathogenic bacillus hitherto described. This bacillus is closely adapted to the human organism but it is not wholly limited to growth upon or within that organism, since it exhibits a well-marked and strikingly peculiar action upon certain laboratory animals. There would seem to be justification for the erection, in the case of this bacillus, of a new pathogenic species which I propose to call *Bacillus mortiferus*.

EXPLANATION OF PLATES.

PLATE XLII.

FIG. 1. Drawing of a section of the human liver, showing different stages of the necrotic process. Natural size.

PLATE XLIII.

FIG. 2. Central necrosis of a lobule in the human liver. The dark portions around the periphery of the necrotic area are bacteria. $\times 75$.

PLATE XLIV.

FIG. 3. A portion of the liver of Rabbit No. iii, showing, (a) necrotic material, (b) formation of dense fibrous tissue, (c) lobules more or less involved by invading fibrous tissue arising from Glisson's capsule. $\times 20$.

FIG. 4. Smear preparation of *Bacillus Mortiferus*.

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

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NOTE. Since the publication of the preliminary report upon *Bacillus mortiferus* there have appeared in print two articles upon pathogenic anaërobic bacteria. One by Norris,¹ the other by Albarran and Cottet.² The former describes a bacillus obtained from a case of abscess of the liver which bears some resemblance to *Bacillus mortiferus*, but which differs in morphology, cultural and pathogenic properties. The latter investigated the anaërobic bacteria occurring in abscesses of the genito-urinary tract and added no new species to those already given in this paper.

¹ *Journal of Medical Research*, 1901, I, 97.

² *La presse médicale*, 1903, xi, 85.