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ETIOLOGY OF YELLOW FEVER.

I. Symptomatology and Pathological Findings of the Yellow Fever Prevalent in Guayaquil.

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Plates 31 to 34.

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In this paper it is proposed to describe the clinical features and pathological changes observed in yellow fever cases admitted to the Yellow Fever Hospital in Guayaquil.[1] It may be stated at the outset that in an analysis of 172 cases no clinical or pathological facts were brought to light which had not been described by previous students of yellow fever in Guayaquil[2] or elsewhere. The yellow fever cases occurring in Guayaquil present no special feature; the disease is classic in all its aspects. For the sake of clearness the general clinical features and the individual symptoms of the disease will be described separately.

[1] This hospital is under the direction of Dr. Wenceslao Pareja. Dr. Pareja not only pointed out many interesting clinical features but also performed autopsies for the members of the Yellow Fever Commission during their sojourn in Guayaquil. I am greatly indebted to Dr. Pareja for his cooperation in my investigations and to Dr. Charles Elliott of the Commission for permission to use some of his clinical notes made on about half the total number of cases coming under my observation during my stay. The Yellow Fever Commission of the International Health Board was composed of Dr. Arthur I. Kendall, Dr. Charles A. Elliott, and Mr. Herman Edward Redenbaugh of Northwestern University Medical School, Chicago; Dr. Mario Lebredo of Las Animas Hospital, Havana, Cuba; and Dr. Hideyo Noguchi of The Rockefeller Institute for Medical Research, New York.

[2] Strong, P. P., Tyzzer, E. E., Brues, C. T., Sellards, A. W., and Gastiaburu, J. C., Harvard School of Tropical Medicine, Report of the first expedition to South America, 1913, Cambridge, 1915, 180–200.

Clinical Features.

General Symptomatology.

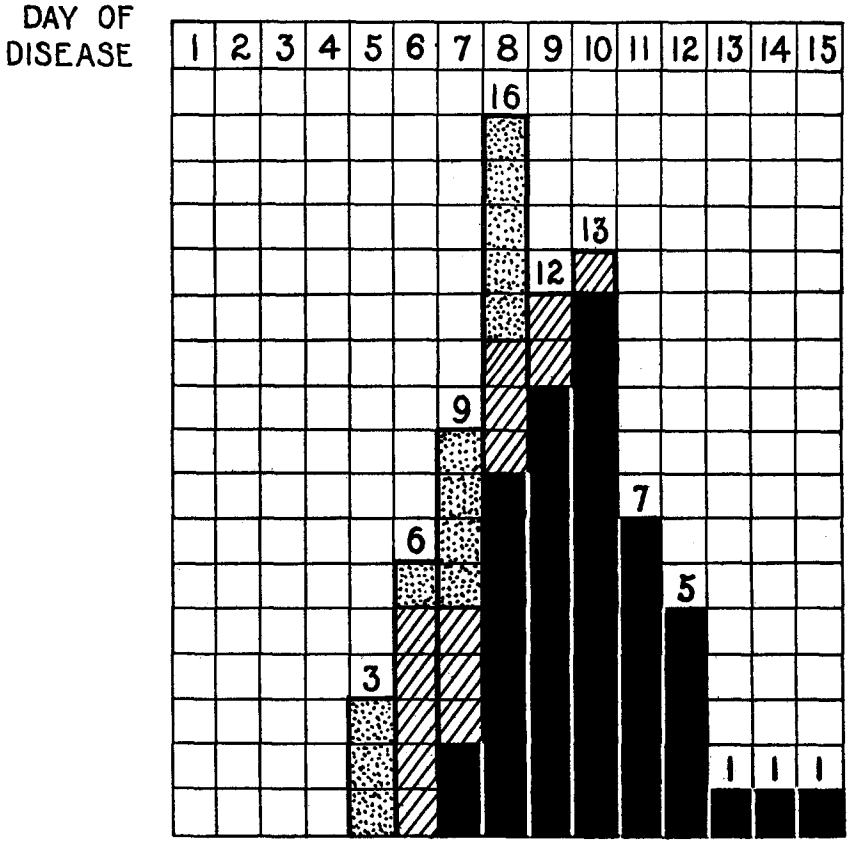
The incubation period varies from 3 to 6 days. It is difficult to determine the maximum. There may be prodromal symptoms for 1 or 2 days, but the onset is usually sudden, ushered in by fever, with or without chills. The patient feels gravely ill and in most cases goes to bed at once, with severe headache, pains in the loins, and anorexia; myalgia of the back, neck, and limbs is often intense, especially on pressure. Nausea and vomiting are frequently present. Insomnia and prostration follow. There is almost always tenderness in the epigastric region which gradually becomes aggravated as the disease progresses. The tongue has a heavy white coat with red tip and edge; later it may become brownish and dry. A peculiar, cadaveric-like odor emanates from the mouth. The gums are congested, swollen, and show a tendency to bleed on pressure. There is great thirst. The conjunctivæ are markedly suffused, becoming yellowish on the 2nd to 3rd day, sometimes with a few ecchymoses on the 6th to 7th day. The icterus of the conjunctivæ increases in the several days following and may persist 2 to 3 weeks in severe cases, although in milder ones it disappears in about 7 days. The black vomitus may occur on the 1st day or as late as several days after onset, or it may only be found in the stomach at autopsy. The skin is usually dry and icteric, and the patient suffers from intense epigastric pain. The gums may bleed profusely at this stage. The urine is reduced in volume; in many cases there is anuria for a day; the urine is dark, greenish, or brown, with abundant albumin and casts. Epistaxis occurs in many cases. Hiccoughs and other nervous symptoms (delirium, coma, convulsions) due to uremia and cholemia are frequent. Death may occur between the 4th and 9th days, rarely earlier or later.

Individual Symptoms.

Fever.—The fever is very high for 1 to 2 days, reaching 39–41°C., then drops to about 38°C. and may persist from 3 to 8 days. On the average the temperature drops to 37° or even to 36°C. after 8 days and may continue to be subnormal for several days.

The relation between the temperature and the severity of the infection among those who recovered is interesting.

Recovered Cases.—There were 74 cases of yellow fever which could be analyzed. These cases came under our observation at different



TEXT-FIG. 1. 74 non-fatal cases analyzed according to defebrescence and severity of the disease. The light shaded area signifies mild, the cross-hatching moderately severe, and the solid black severe cases.

stages of the disease, ranging from the 2nd to the 8th day. The temperature in early cases (2nd, 3rd, 4th days) was usually very high, the majority being over 40°C., while those admitted later (5th to 8th days) had a temperature of 39°C. or below. The abate-

ment of fever to normal, or 37°C., occurred as convalescence was established. In the majority of instances in which the attack was mild or of moderate severity the temperature returned to normal on the 5th and 6th days. Those whose temperature returned to 37°C. on the 7th day were cases of moderate severity, though a few mild and severe cases had similar febrile reactions. The cases in which the temperature returned to 37°C. on the 8th, 9th, or 10th day were nearly all severe, and all those in which the normal was not reached until the 11th day or later were severe. The deduction from

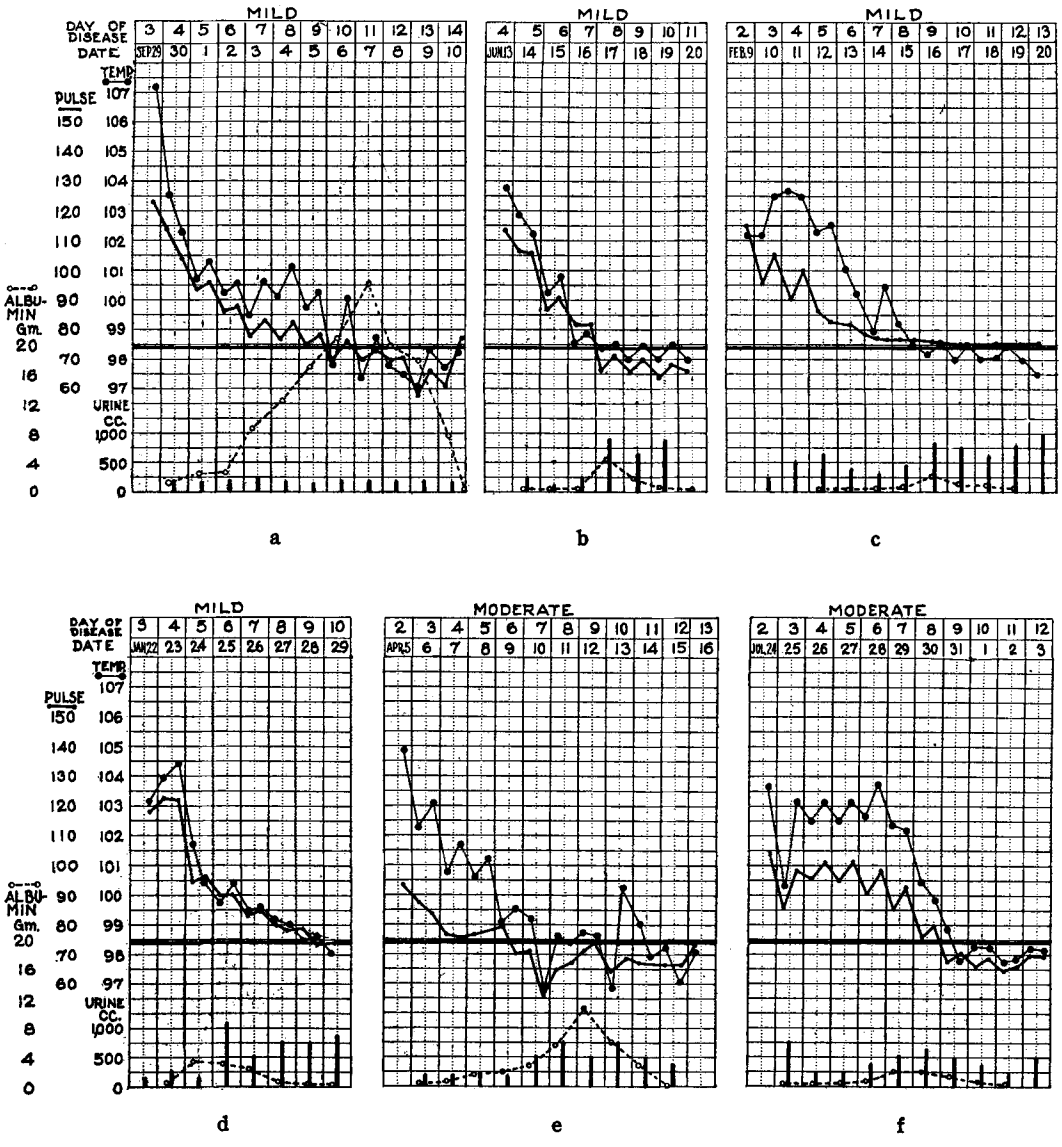
TABLE I.

Relation between Time of Defebrescence and Severity of the Disease.

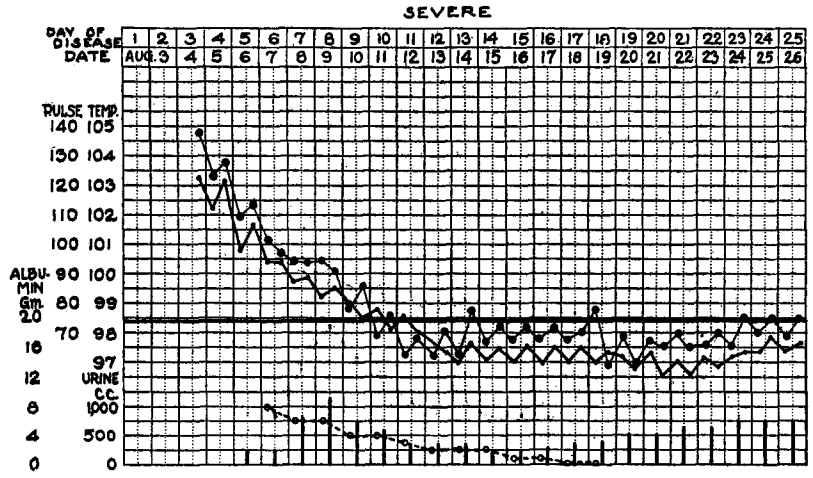
Day of disease when temperature reached 37°C.	Mild.	Moderate.	Severe.	Total.
5	3			3
6	1	5		6
7	4	3	2	9
8	5	3	8	16
9		2	10	12
10		1	12	13
11			7	7
12			5	5
13			1	1
14			1	1
15			1	1
Total.....	13	14	47	74

these observations is that the milder the attack the sooner the temperature returns to normal, and *vice versa*. In mild but undoubted cases of yellow fever the earliest date on which the normal has been attained is the 5th day of the disease (4 per cent). The bulk of the cases reached the normal on the 7th (12 per cent), 8th (20 per cent), 9th (16 per cent), or 10th (17 per cent) day. Text-fig. 1 and Table I show the distribution of cases from the standpoint of the time of defebrescence and severity of the disease.

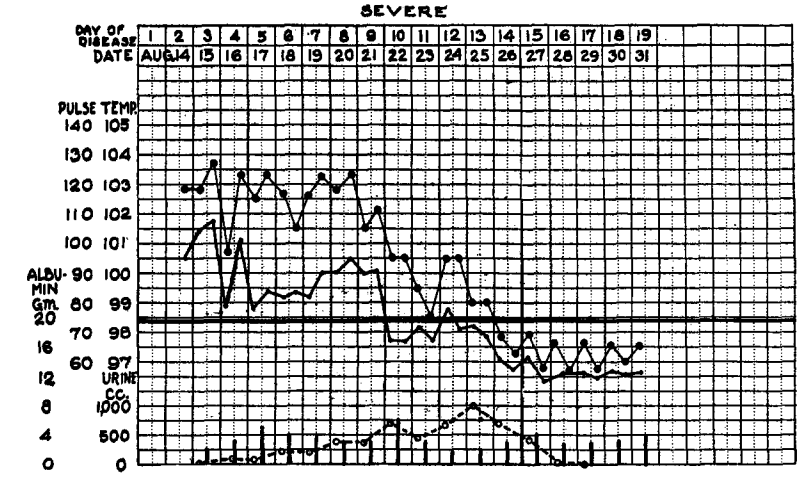
It was found that in the cases which were admitted to the hospital from the 2nd, 3rd, or 4th day of the disease there are several instances in which the temperature registered higher the following



TEXT-FIG. 2, *a* to *f*. Mild and moderate cases of yellow fever. (*a*) Case 35. Age 25 years. (*b*) Case 36. Age 21 years. (*c*) Case 37. Age 22 years. (*d*) Case 38. Age 20 years. (*e*) Case 39. Age 18 years. (*f*) Case 9. Age 19 years.



a



b

TEXT-FIG. 3, *a* and *b*. Severe cases of yellow fever. (*a*) Case 19. Age 25 years. (*b*) Case 8. Age 21 years.

day than at the time of admission or that in some instances there was a distinct remission on the 2nd or 3rd day of the disease. Again in rare instances a relatively high fever (39–39.6°C.) lasted several days. The rapidity of lysis is somewhat variable in the different cases, but the drop in the curve is rather steep. When the temperature reaches 37°C. it usually goes further down, even as low as 36°C. within a few days and may remain subnormal for several days before it attains the normal permanently. Text-figs. 2, *a* to *f*, and 3, *a* and *b* illustrate these points.

Fatal Cases.—A study of the temperature in relation to fatal cases seemed important to an understanding of the clinical features of this disease. Among the records for the year (1918) I was able to utilize 66 cases of persons dying of yellow fever (Table II and Text-fig. 4). The bulk of deaths occurred on the 5th, 6th, and 7th days, but especially on the 5th and 6th. On the 4th and 8th, 9th, and 10th days the death rates were the same, being about one-third of those for the 5th and 6th and one-half of those for the 7th day. Death seldom occurred on the 2nd or 3rd day or after the 11th day of disease.

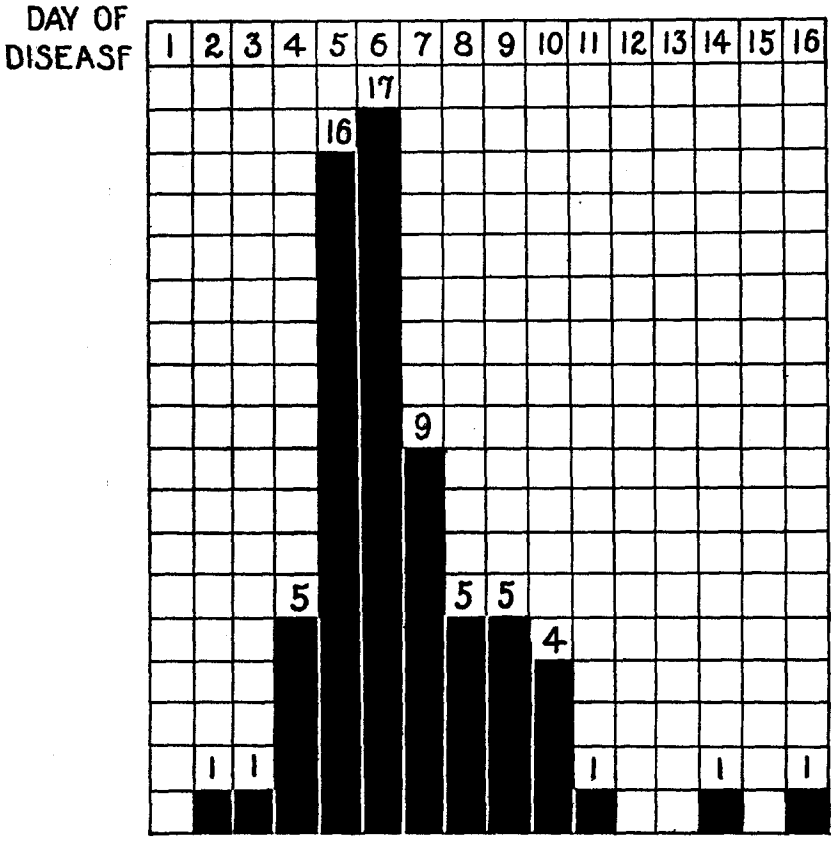
TABLE II.

Fatal Cases.

Day of disease on which death occurred.	No. of cases.
2nd	1
3rd	1
4th	5
5th	16
6th	17
7th	9
8th	5
9th	5
10th	4
11th	1
14th	1
16th	1
Total	66

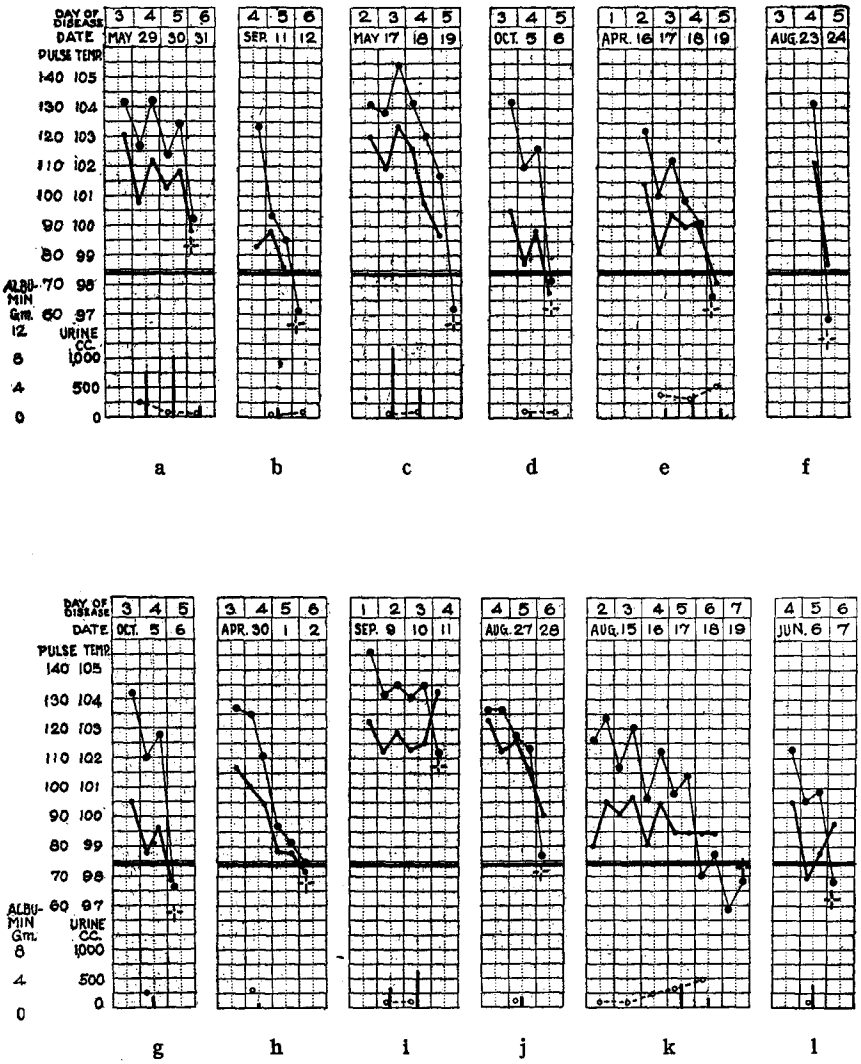
Total No. of cases....140
No. recovered.... 74
" died.... 66 (47.1 per cent).

The temperature curves of these fatal cases (Text-fig. 5, *a* to *l*) are noteworthy as showing the rather rapid fall of temperature towards death. The initial fever in these cases was very high when observed during the early stage of the disease (above 40°C.), and some showed



TEXT-FIG. 4. The chart shows the day of disease on which death occurred in 66 fatal cases.

nearly 40°C. even on the 4th or 5th day. Death took place with a temperature as high as 39°C. in some and as low as 36°C. in others. In a few instances the temperature fell to about 37°C. or even 36° or 35°C. on the day of death but registered a sudden rise to 38°C., and in one case to 40.6°C., just before death.



TEXT-FIG. 5, *a* to *l*. Fatal cases of yellow fever. (*a*) Case 40. Age 28 years. (*b*) Case 41. Age 24 years. (*c*) Case 42. Age 20 years. (*d*) Case 43. Age 19 years. (*e*) Case 44. Age 28 years. (*f*) Case 45. Age 25 years. (*g*) Case 46. Age 18 years. (*h*) Case 47. Age 18 years. (*i*) Case 48. Age 13 years. (*j*) Case 49. Age 11 years. (*k*) Case 10. Age 26 years. (*l*) Case 50. Age 24 years.

The analysis of the febrile reaction of man to yellow fever infection becomes important in a discussion of the febrile reaction of certain experimental animals when inoculated with the blood or organ emulsions from yellow fever patients.

Disturbances in the Renal Functions.—In almost all yellow fever cases the urine contains from the 1st day of illness more or less albumin which continues and increases in quantity. On the 2nd or 3rd day granular and epithelial casts appear, being abundant in severe cases. In fatal cases the quantity of urine rapidly decreases the 1st and following days until there may be complete suppression, perhaps anuria, for 24 hours or longer previous to death. The amount seldom exceeds 500 cc. In the non-fatal cases there is a similar diminution of urine during the first 4 or 5 days, but from that time there is a gradual return to the normal output. In many cases the quantity reaches 1,000 cc. on the 8th, 9th, 10th, or 11th day, while in some the secretion may be only 500 cc. or less for many more days. The casts and albumin are less in mild cases and disappear earlier than in the severe cases, in which they may persist for from 2 to 3 weeks. They are present in largest quantity some time during the 2nd week, and as early in rare instances as the 5th or 6th day. The average maximum of albumin is about 5 gm. per liter. In a few instances it went up to 18 gm. In fatal cases the amount of albumin was not very large, being about 1 to 2 gm. per liter, although there were a few instances in which it was somewhat over 5 gm. per liter during 24 hours. In a few apparently severe cases the amount of albumin was comparatively small, 1 to 2 gm.

During the 1st and 2nd weeks of the disease erythrocytes are always found in varying quantities in the urine.

Jaundice.—This is one of the most constant manifestations of yellow fever. The intensity of jaundice is, in the majority of cases, in proportion to the severity of the disease. In a very mild case it appears later and disappears sooner than in more severe cases and may be so slight that careful attention alone will reveal its presence. In average non-fatal cases jaundice may be detected on the 3rd day of the disease, first in the scleras and then in the lighter parts of the skin. On the 4th or 5th day the jaundice deepens, and the entire body assumes a light saffron to ocher-yellow hue. In milder cases

the height of jaundice is reached within the 1st week, while in severer cases the color goes on deepening for another week until the appearance of the patient varies from a grayish green to bright yellow. In fatal cases the jaundice may be pronounced or rather slight according to the period of the disease at which death occurred. The longer the patient lives the deeper is the jaundice as a rule. Jaundice becomes more evident after death, owing to the cessation of the blood circulation.

Bile pigments are present in the blood, pericardial, pleural, peritoneal, and cerebrospinal fluid, the adipose tissues, urine, various organs, muscles, glands, the skin, and mucous and serous membranes. The cartilages are also stained. The brains are not noticeably yellow. The urine becomes brownish yellow on the 2nd or 3rd day, and the color becomes deeper as the disease advances until it reaches the color of dark greenish brown or deep brownish yellow. In the bladder of patients dying during the 1st week the urine is of brownish yellow color.

Bile pigments are readily recognizable in the serum or plasma drawn after the 3rd day and give them a deep yellowish brown color in a later stage of the disease.

Leucocytes.—As a rule there is a slight hyperleucocytosis on the 1st day of the disease, but the number of leucocytes soon returns to normal, and in a few days a marked leucopenia sets in. There were a few exceptions, however, in which marked hyperleucocytosis was maintained for several days. The differential count showed a high percentage of polymorphonuclear leucocytes.

Hemorrhages, Vascular Injection, and Herpes.—Hemorrhagic diathesis is the third cardinal symptom of yellow fever and is never absent from fully developed cases.

During life hemorrhages are manifest in various forms, such as epistaxis, hematemesis, melena, hematuria, gingival hemorrhages, subconjunctival ecchymoses, and in occasional cases subcutaneous ecchymoses and petechiæ. Epistaxis is frequent and often profuse and may be one of the early symptoms. Hematemesis begins usually in the 1st week and becomes severer in the 2nd week. The vomitus is at first yellowish brown, but soon a coffee-ground color to which the term "black vomit" in yellow fever owes its origin. It is

a mixture of mucus, blood clot, and food in a semidigested state. This symptom may be absent in fatal cases, in which the coffee-ground contents may be first found in the stomach at autopsy. In severe but non-fatal cases the black vomit may occur in the 2nd week. Melena is a concomitant of hematemesis and is usually present in all severe cases. Gingival hemorrhages from swollen gums occur in many cases and are sometimes alarmingly persistent and profuse in severe cases. Hematuria is frequently observed, and in fact the urine of yellow fever patients always contains varying quantities of the blood corpuscles when examined under the microscope. Subcutaneous petechial hemorrhages of various sizes, from that of a pin-head to that of a split pea, were observed in several cases (Figs. 1 and 2).

During the 1st week the superficial vascular system seems to be dilated, and the blood-shot appearance of the conjunctival capillaries of the eyes is one of the most constant symptoms of the disease. The patients usually are flushed in the face in the early stage.

Herpes labialis is frequently present during the 1st week of the illness (Fig. 3).

Pulse.—Relative brachycardia is another well known characteristic symptom of yellow fever and has been observed in the majority of cases in Guayaquil. In many fatal cases, however, the pulse curve went up above that of the temperature a day or two before death. This disproportion of temperature and pulse is shown in the charts elsewhere recorded in this paper. A patient with a temperature of 39.5°C. may have a pulse of 80, and during the convalescent stage as slow as 45 or 50 beats per minute.

Nausea and Vomiting.—Nausea, accompanied by anorexia, is noted from the beginning and is soon followed by vomiting. Vomiting may occur in the beginning, however, or may begin several days later. The character of the black vomitus has already been described. It often appears bilious at first.

Pains.—Intense headaches, frontal, orbital, or general, are complained of by all patients during the first 3 or 4 days. Pains in the muscles of the trunk, loins, and calves, and sometimes in the arms and thighs are observed in all cases, being extremely intense in some. They are most marked during the first 3 days; later the patient may

make no reference to them unless questioned, being preoccupied probably by the cephalalgia. Epigastralgia is usually present and is almost intolerable in some severe cases. In mild cases the epigastric region is tender to pressure. Pains in the back in severe cases may be due to the acute nephritis. The liver is palpable, enlarged, and tender to pressure. The spleen is normal. The tongue is coated, with free red tip and edge. The lungs often show slight bronchitis.

Onset and Course of Yellow Fever in Man.

In the foregoing paragraphs the clinical features which constitute the disease known as yellow fever have been set forth. By bringing together the symptoms which occur concomitantly during the course of the infection, the reader can picture to himself the appearance of a mild, moderate, severe, or fatal case. A brief resumé is given here, however.

Mild Infection.—Onset with severe headache, coated tongue with red tip and edge, suffusion of conjunctivæ, myalgia, anorexia, and nausea, accompanied by a temperature of about 39° or 39.5°C., usually without chill. The patient is rather ill, but still able to go about. There is a moderate hyperleucocytosis which presently may drop to normal or to leucopenia. The pulse is relatively slow. A trace of albuminuria and icterus are present during the next few days. All symptoms rapidly disappear within a week or a little more.

Moderate Infection.—All the symptoms just described are present, together with black vomit during the 1st week. The patient is ill enough on the 1st day to go to bed. The presence of albumin and casts in the urine, oliguria, and icterus are rather pronounced and may persist for 10 days or more, when convalescence begins. Gastralgia is present. The liver is palpable and tender.

Severe Infection.—All symptoms are much aggravated, and there may be rigor and a fever around 40°C. Epistaxis, hematemesis, hematuria, melena, and gingival hemorrhages follow. Icterus is intense, and the urine diminishes rapidly as the disease advances, and great quantities of albumin, casts, and bile pigments are contained in it. The patient may become delirious at the end of the

1st week. The epigastric pain is severe. Profuse hemorrhages, hypothermia, and exhaustion ensue. By the 12th day the urine begins to increase in volume and continues to do so for subsequent days. With the increased urine the patient begins to improve, and within another week or two all the symptoms except jaundice and albuminuria gradually disappear.

Parotitis and a secondary fever on the 14th to 16th day were observed in certain cases as complications.

Fatal Infection.—The onset of the yellow fever that ends in death is the same as that observed in the severe non-fatal cases. Both are very grave from the beginning. Some cases appear to be in a state of exaltation, with brightly flushed face and blood-shot eyes, when brought in on the 2nd day, but the bloody vomit soon begins, and the patient is rapidly seized by an agony of pains. Albumin, casts, and blood cells are present in the urine. On the 3rd or 4th day there may be total anuria. The patient soon becomes delirious, then comatose, and dies in convulsions. There may be a sudden drop in temperature before death or in some instances a sudden rise to near 40°C. When death occurs after the 6th day the temperature is already low, sometimes below 37°C. Jaundice is always present in fatal cases. In some cases the black vomit, or rather hematemesis (still quite bright red) occurs near death or may be found at autopsy.

The foregoing summary is intended only to give a very general impression, the details being recorded in other papers.

Autopsy Findings in Yellow Fever in Man.

This part of the subject is important in completing our knowledge of the disease as it affects man. All the clinical manifestations are only the apparent characteristics of the disease and are explained and extended by the pathological findings.

Postmortem rigor and lividity are pronounced. There is intense jaundice throughout the entire body. The nostrils and mouth may be partly filled with blood clots and the face smeared with blood. The region about the anus is often stained with melena. Uterine hemorrhages were observed in young women. The skin, subcutaneous tissues, and muscles are yellow.

Lungs.—Often edematous; show marked hypostasis; crepitant. In every case there were ecchymotic hemorrhages, variable in size and distribution. The size varies from a few millimeters square to the size of a split pea, and is sometimes as large as a pigeon's egg. The hemorrhagic foci are sharply defined in some and diffuse in others. If recent they are vivid red, if several days old bluish red. On section they are seen to extend deep into the substance of the lungs, some into the interior. They are discrete and multiple, and the number varies in different cases and in the two lungs.

Heart.—Often shows hemorrhagic foci in the pericardium, which contains icteric fluid and is often dilated on the right side and in diastolic condition. The myocardium is grayish yellow, brittle, and cloudy. Numerous punctiform ecchymoses are frequently found on the surface. The endocardium is clear, with occasional punctiform hemorrhages along the papillary muscles. The valves are intact.

Liver.—Hyperemic and often somewhat enlarged. The color varies, yellowish brownish red, ocher-yellow, saffron-yellow, light greenish yellow, brownish yellow. The whole may be of uniform color or shaded, blended, or minutely mottled. The yellower or greener color indicates a more advanced stage of degeneration, in which the parenchyma is brittle and tears easily when handled with forceps. In a brownish red liver the tissue still retains much of its normal consistency. Minute ecchymotic spots are sometimes visible on the surface.

Gall Bladder.—Usually full of deep greenish yellow bile. There may be multiple ecchymoses in the wall.

Kidneys.—Enlarged, highly hyperemic, and reddish yellow in color. Varying number of ecchymoses, some punctiform and some as large as a bean, may be present in the capsule, which strips easily. In a few instances punctiform hemorrhages were found in the cortex. On section hyperemia is noticed along the junction of the cortex and medullary portion. The cortex is broader and shows general swelling and cloudiness. The medulla is succulent and icteric. The renal pelvis may be free, but not infrequently it contains a blood clot, or numerous punctiform hemorrhages are seen irregularly situated. The kidneys, therefore, show acute parenchymatous inflammation.

Suprarenal Glands.—Appear to be congested and more friable than normally. In one instance an extensive hemorrhage was found in the perinephritic adipose tissue.

Gastrointestinal System.—The stomach usually contains a viscid semifluid of coffee-ground appearance, known as the black vomit or *vomito negro*. In some instances freshly extravasated blood gives the gastric contents a dark reddish hue, or they may be dark green in color with black particles. The serosa is free from any ecchymoses, but the mucosa is intensely injected with more or less numerous ecchymoses, particularly near the cardia.[3] The small intestines as well as the colon are similarly affected and contain a tarry fluid (melena).

Bladder.—Except for occasional ecchymoses on the serosa nothing special has been observed. The bladder is often full.

Uterus and Ovaries.—Intense injection of the endometrium and sometimes hemorrhage in the uterus. The ovaries are somewhat injected. In one instance there was hemorrhage of both ovaries.

Testicles.—No change found.

Spleen.—Apparently normal.

Lymphatic Glands.—Swelling and hemorrhages were observed in the bronchial, mesenteric, and other lymphatic glands. This condition, as well as the constant ecchymoses in the lungs, seems to have received little attention from previous investigators.

Serous Membranes.—Pleuræ, peritoneum, and omentum are usually free from hemorrhages.

Skin and Mucous Membranes.—Occasional petechial hemorrhages were observed.

Nervous System.—The central nervous system is macroscopically unchanged. The cerebrospinal fluid is icteric and the brain edematous. The membranes are injected.

Histological Findings.

Lungs (*Figs. 4 to 7*).—In the majority of instances areas of hemorrhage of varying extent are found and also small foci of infiltration with polymorphonuclear leucocytes. The alveoli are filled with

[3] This has been constantly observed by Dr. Pareja in his long experience.

polymorphonuclear and large endothelial cells and red blood corpuscles. The thrombi in some vessels are similar to those seen in infarctions.

Liver (*Figs. 8 to 11*).—The liver is necrotic in the large proportion of cases, and the parenchyma is full of extravasated blood. Only around the vessels are the living cells found, better preserved around the central vessel than around the portal canal. A moderate amount of pigment is sometimes found within the bile capillaries. The blood is distributed throughout the necrotic areas and not always confined to the blood vessels. Mitotic figures are met with among the liver cells. Most liver cells are vacuolated, and some are distended with vacuoles. Hemorrhagic areas are found. Numerous red-staining cells mingle with those less degenerated. There are a few granules in the liver cells but no pigment. In the region of the portal canal small foci of lymphoid and plasma cell infiltration are encountered.

Kidneys (*Figs. 12 to 15*).—The convoluted tubules are somewhat dilated with granular excretion. There are many deeply stained hyaline and granular casts. The epithelium of the convoluted tubules shows granular and somewhat vacuolated cytoplasm. The glomeruli are moderately or considerably injected; there is rather marked injection of the medulla with several hemorrhagic areas.

Stomach.—A few minute foci of infiltration with polymorphonuclear leucocytes; in certain areas a more diffuse infiltration of lymphoid and plasma cells (some bacilli). The superficial portion of the mucosa is markedly congested. The mucosa is somewhat injected in places.

Large and Small Intestine.—Injection and occasional hemorrhages.

Heart.—The muscle fibers show one or more vacuoles situated in the central portion, suggestive of fat. Certain fibers appear somewhat swollen. The nuclei are large and vesicular.

Spleen.—Numerous large phagocytes containing red cells. Follicles atrophied in one case; in another much blood in the pulp. A large number of phagocytic cells appear in certain areas. These contain red cells and red-staining granules.

Lymph Nodes.—(1) Some degeneration and phagocytosis centrally situated in the follicles. (2) Peripheral sinuses filled to a large extent

with polymorphonuclear leucocytes and a small number of phagocytic cells. The lymph follicles show small areas of degeneration centrally situated.

Pancreas.—Certain of the gland alveoli show small groups of degenerated cells. Sometimes there are no lesions.

Adrenals.—There is a marked degree of parenchymatous degeneration, affecting chiefly the medulla, and considerable congestion. In some cases the adrenals are intact.

Nervous System.—Nothing abnormal.

SUMMARY.

The clinical and pathological features of the yellow fever prevalent in Guayaquil conform with those described by other investigators of this disease as it has occurred elsewhere, both epidemically and endemically.

EXPLANATION OF PLATES.

PLATE 31.

FIG. 1. Patient Ch. The photograph, which was taken on the 5th day of the disease, shows large and small areas of subcutaneous hemorrhage on chest and arms, also on the temple. The blotch on the left breast was caused by the application by the patient of mustard plaster. The patient died on the 7th day.

FIG. 2. A patient who was severely ill but finally recovered. There were extensive subcutaneous hemorrhages all over the body of a mottled appearance but with no actual circumscribed spots.

FIG. 3. Patient Co. The photograph, which was taken on the 3rd day of the disease, shows herpes labialis, particularly of the lower lip. The patient died on the 4th day.

PLATE 32.

FIGS. 4 to 7. Sections of lung from four different cases of yellow fever, fixed with Zenker's fluid and stained with eosin and methylene blue. Hemorrhagic areas, varying in extent, can be seen in all these lesions. They are well defined with respect to the normal tissue (Fig. 4). There is a varying degree of edema. Fig. 4 is from a patient dying on the 6th day, Fig. 5 from a patient dying on the 5th day, Fig. 6 from a patient dying on the 8th day, and Fig. 7 from a patient dying on the 7th day. $\times$ 150.

PLATE 33.

FIGS. 8 to 11. Sections of liver from cases of yellow fever, fixed with Zenker's fluid and stained with eosin and methylene blue. The general character of the lesion consists in necrosis and vacuolization of the liver cells. Some groups of cells are completely disintegrated. The necrotic areas are occupied by debris and hemorrhage, particularly marked in Figs. 10 and 11. Fig. 8 is from a patient dying on the 6th day, Fig. 9 from a patient dying on the 5th day, Fig. 10 from a patient dying on the 8th day, and Fig. 11 from a patient dying on the 7th day. × 150.

PLATE 34.

FIGS. 12 to 15. Sections of kidney from cases of yellow fever, fixed with Zenker's fluid and stained with eosin and methylene blue. The general character of the lesion is the same in all these sections: swelling and degeneration of the renal epithelia in the tubules with varying degrees of hemorrhage into the connective tissue. The glomeruli are highly congested; some of the epithelia of the tubules are vacuolated and desquamated. The lumina of the tubules are filled with granular casts. Fig. 12 is from a patient dying on the 6th day, Fig. 13 from a patient dying on the 5th day, Fig. 14 from a patient dying on the 8th day, and Fig. 15 from a patient dying on the 7th day. × 150.

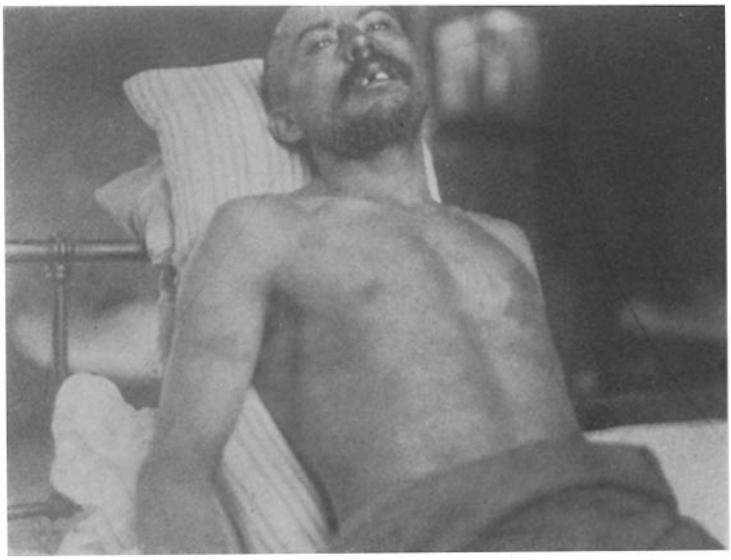


FIG. 1.

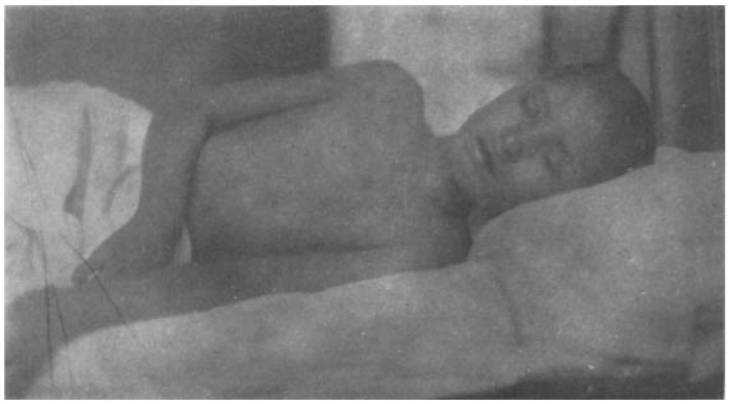


FIG. 2.

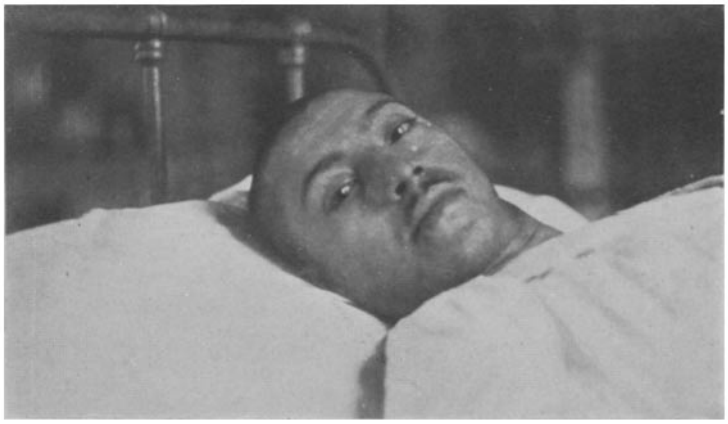


FIG. 3.

(Noguchi: Etiology of yellow fever. I.)

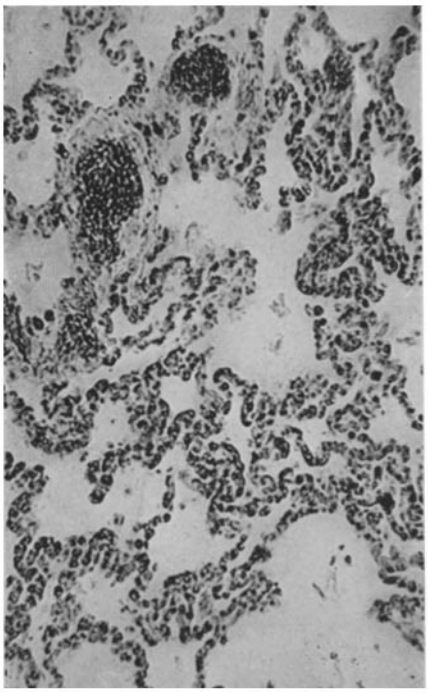


FIG. 4.

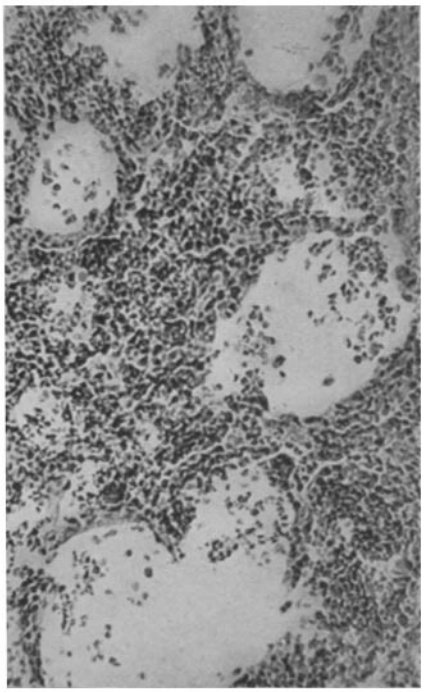


FIG. 6.

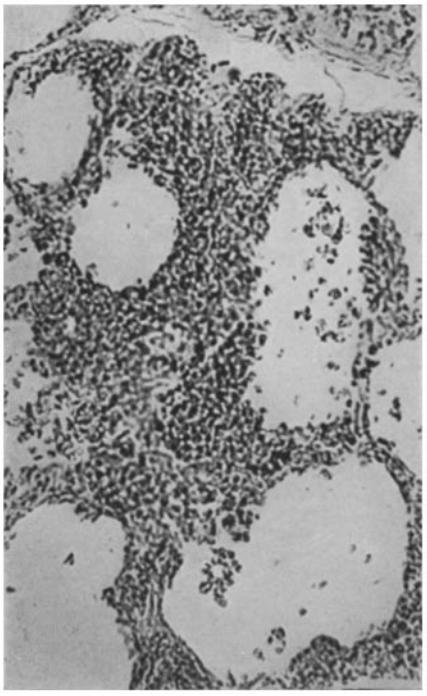


FIG. 5.

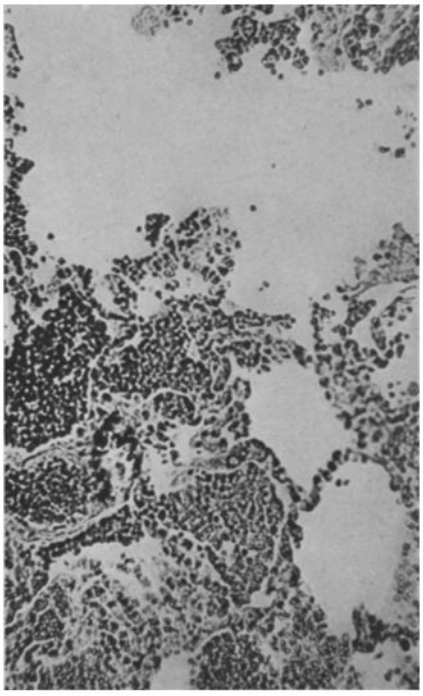


FIG. 7.

(Noguchi: Etiology of yellow fever. I.)

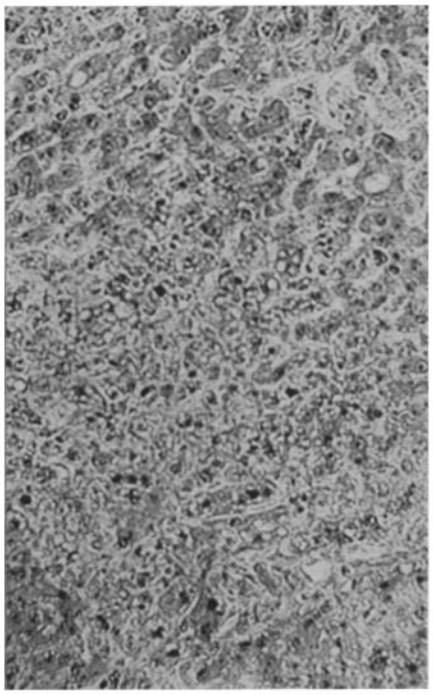


FIG. 8.

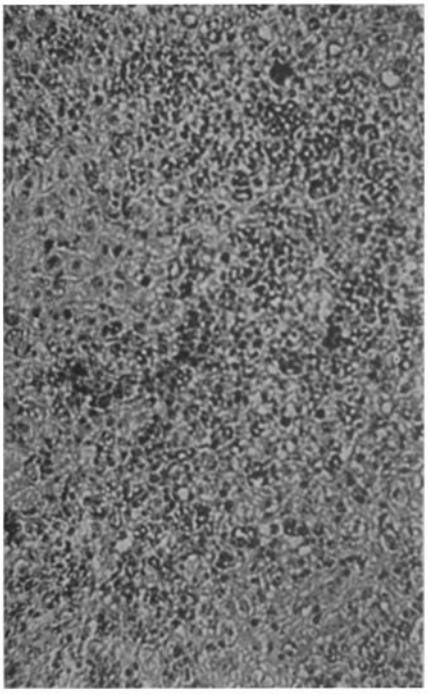


FIG. 10.

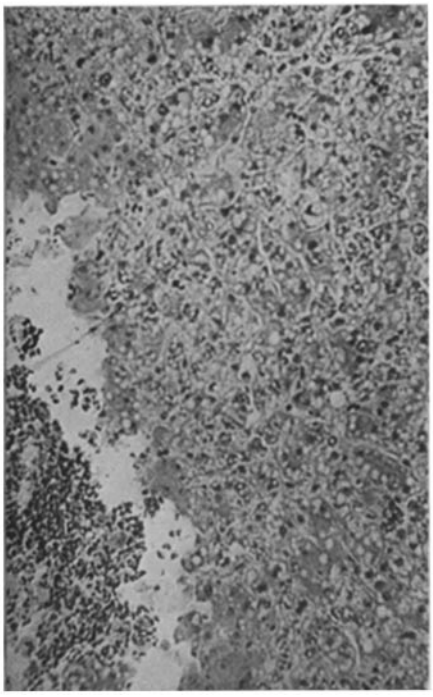


FIG. 9.

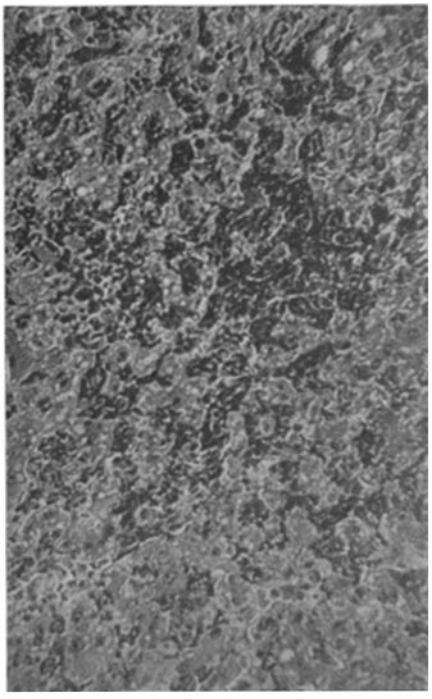


FIG. 11.

(Noguchi: Etiology of yellow fever. I.)

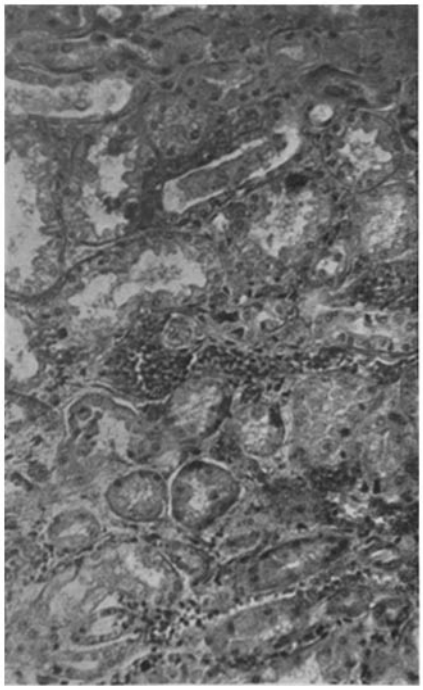


FIG. 12.

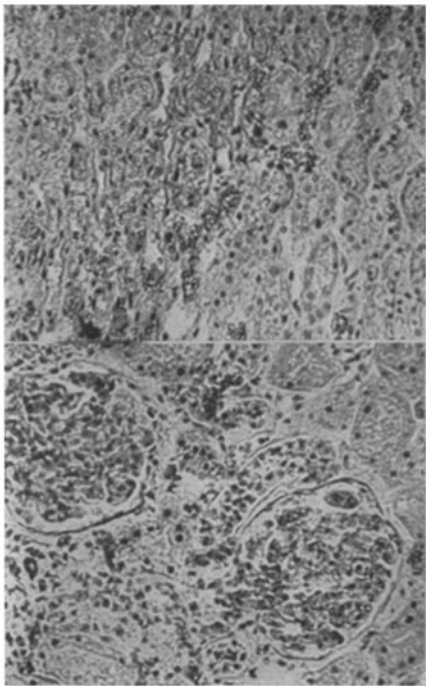


FIG. 14.

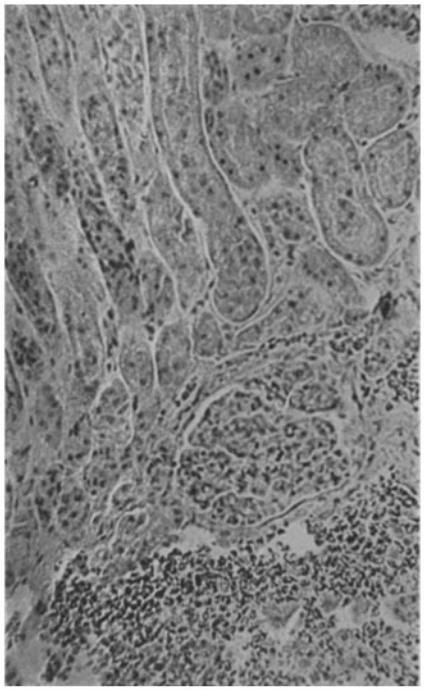


FIG. 13.

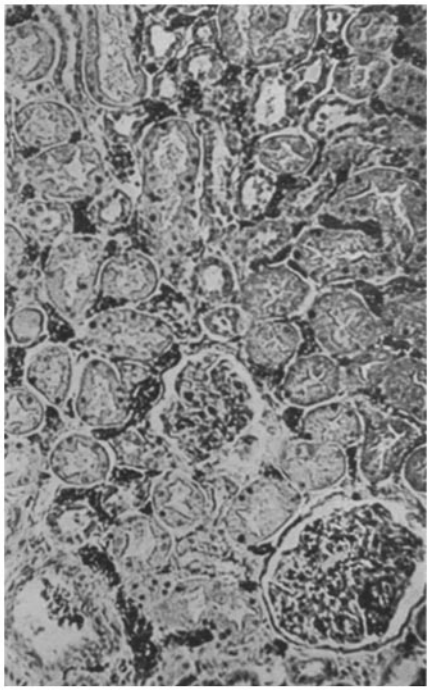


FIG. 15.

(Noguchi; Etiology of yellow fever. I.)