OUTLINE OF INVESTIGATIONS

INTO

THE NATURE, CAUSES AND PREVENTION

OF

ENDEMIC AND EPIDEMIC DISEASES,

AND MORE ESPECIALLY MALARIAL FEVER,

DURING A PERIOD OF THIRTY YEARS,

WITH A CLAIM TO PRIORITY IN THE DETERMINATION OF THE CHEMICAL AND MICROSCOPICAL CHARACTERS AND CHANGES OF THE BLOOD IN THE VARIOUS FORMS OF MALARIAL PAROXYSMAL FEVER,

AND

THE APPLICATION OF THE RESULTS OF THESE INVESTIGATIONS TO MEDICAL DIAGNOSIS AND MEDICAL JURISPRUDENCE.

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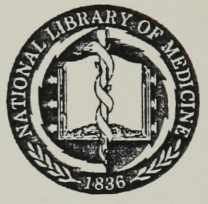

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OUTLINE OF INVESTIGATIONS INTO THE NATURE, CAUSES AND PREVENTION OF ENDEMIC AND EPIDEMIC DISEASES, AND MORE ESPECIALLY MALARIAL FEVER, DURING A PERIOD OF THIRTY YEARS, WITH A CLAIM TO PRIORITY IN THE DETERMINATION OF THE CHEMICAL AND MICROSCOPICAL CHARACTERS AND CHANGES OF THE BLOOD IN THE VARIOUS FORMS OF MALARIAL PAROXYSMAL FEVER AND THE APPLICATION OF THE RESULTS OF THESE INVESTIGATIONS TO MEDICAL DIAGNOSIS AND MEDICAL JURISPRUDENCE.

RÉSUMÉ D'INVESTIGATIONS DANS LA NATURE, LA CAUSE ET LA PRÉVENTION DES MALADIES ENDÉMIQUES, SURTOUT DE LA FIEVRE PALUDÉENNE. EXPÉRIENCE DE TRENTE ANS ET PRETENTION À LA PRIORITÉ DANS LA DÉFINITION DES CARACTÈRES CHIMIQUES ET MICROSCOPIQUES, DES CHANGEMENTS DU SANG DANS LES DIVERSES FORMES DE LA FIEVRE PALUDÉENNE AIGUË, ET L'APPLICATION DES RESULTATS DE CES DÉCOUVERTES A LA DIAGNOSTIQUE ET A LA JURISPRUDENCE MEDICALES.

UMRISS DER WÄHREND DREISSIG JAHRE ANGESTELLTEN UNTERSUCHUNGEN ÜBER DAS WESEN, DIE URSACHEN UND VERHÜTUNG ENDEMISCHER UND EPIDEMISCHER KRANKHEITEN, INSBESONDERE DES MALARIAFIEBERS, MIT PRIORITÄTSANSPRUCH AUF DIE BESTIMMUNG DER CHEMISCHEN UND MICROSCOPISCHEN EIGENSCHAFTEN UND VERÄNDERUNGEN DES BLUTES IN DEN VERSCHIEDENEN ARTEN DES INTERMITTIRENDEN MALARIAFIEBERS, UND DIE ANWENDUNG DER ERGEBNISSE DIESER UNTERSUCHUNGEN AUF DIE DIAGNOSE UND GERICHTLICHE MEDICIN.

BY JOSEPH JONES, A.M., M.D.,

Of New Orleans, La.

The investigations of the author on the physical, chemical, microscopical and pathological changes of the blood, organs, secretions and excretions in human beings suffering with the various forms of malarial fever, were instituted in the Marine Hospital and Poor House of Savannah, Georgia, in the year 1856, and were vigorously prosecuted during three years, 1856, 1857 and 1858.

My first publications were made in the *Southern Medical and Surgical Journal*, edited by Dr. Henry F. Campbell and Dr. Robert Campbell, and published in Augusta, Georgia. In an article published in May, 1858,* after presenting the history, symptoms, chemical analyses and pathological anatomy of the case of diabetes mellitus, and of several cases of malarial fever, the following conclusions were reached:—

If we compare the blood of these cases with that of health, and with the blood of the patient suffering with diabetes mellitus, we will observe the following points of agreement and disagreement:—

1. The colored blood corpuscles are diminished greatly and rapidly in malarial fever. This destruction of the colored blood corpuscles is far more rapid in malarial fever than in diabetes mellitus.

2. The salts of the colored blood corpuscles are diminished to a remarkable extent in malarial fever, while they are normal in amount in the blood of diabetes mellitus.

3. The blood coagulates slowly and the clot is soft in malarial fever, while the reverse was the case in this specimen of diabetic blood.

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* "Case of Diabetes Mellitus," treated by Joseph Jones, A.M., M.D. *Southern Medical and Surgical Journal*, New Series, Vol. XIV, Augusta, Georgia, May, 1858, No. 5, pages 290-315.

4. The fibrin is often diminished in malarial fever, and the serum presents a golden color, while in this case of diabetes mellitus the fibrin was slightly increased and the color of the serum was normal. That the poison of malarial fever induces profound changes in the colored blood corpuscles, and other constituents of the blood, I have demonstrated by the following facts:—

(*a*) The urine of patients suffering with malarial fever contains an increased quantity of iron. The increase of the iron in the urine is subsequent to the destruction of the colored corpuscles in the blood.

(*b*) In examinations of the organs after death, from all the forms of malarial fever—intermittent, remittent and congestive—I have observed that the dark blood of the spleen and liver do not change to the arterial hue when exposed to the action of the oxygen of the atmosphere. After death from phthisis, cirrhosis of the liver, organic disease of the circulatory apparatus and apoplexy and mechanical injuries, as far as my observations extend, the blood of the spleen and liver always changes to the arterial hue when exposed to the action of the oxygen of the atmosphere.

(*c*) Animal starch accumulates in the malarial fever liver, while grape sugar, as far as my observations extend, is absent. I have tested the livers of malarial fever for grape sugar and starch. An abundance of starch* was obtained, without a trace of grape sugar. The livers were set aside and examined after intervals of twelve hours. The last examination was made thirty-six hours after the first. At every examination the result was the same, an abundance of animal starch and no grape sugar. These facts are important, not only in their bearing upon malarial fever, but also in their bearing upon diabetes mellitus. M. Cl. Bernard † has demonstrated that the transformation of glycogenic hepatic matter (animal starch) formed by the liver into glucose is the result of the action of a special ferment, which is formed and exists in the blood, independent of the liver. From the facts which we have previously stated, it is evident that in malarial fever this ferment is destroyed, while the liver still possesses the power of transforming the nitrogenized and non-nitrogenized elements into animal starch. We have now facts sufficient to draw important distinctions between malarial fever and diabetes mellitus. In both diseases the blood corpuscles may be greatly diminished. In both diseases the nervous and muscular forces may be correspondingly diminished. Here the analogy ceases.

The destruction of the colored corpuscles is rapid in severe types of malarial fever, and slow in all forms of diabetes mellitus. The salts of the blood corpuscles are normal, if not increased, in this case of diabetes mellitus, while they are greatly diminished in malarial fever. In malarial fever the blood loses its power of changing its color in the spleen and liver. In malarial fever the color of the liver and the bile is altered, and the spleen is enlarged, softened and filled with a purplish-brown mud. In diabetes mellitus all the organs are normal in appearance. In malarial fever the blood has lost its power of converting animal starch into glucose. In diabetes mellitus this power is greatly increased.

The following table affords a comparison of normal, diabetic and malarial blood:—

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*So abundant is this animal starch in the malarial fever liver, that if a small particle of the substance of the liver be mashed upon a glass slide, treated with a saturated solution of iodine in alcohol, and viewed under the microscope, numerous beautiful blue masses of this animal starch colored by the iodine will be seen. If the fibrous capsule be torn off from the surface of the liver, spread upon a glass slide, and treated with tincture of iodine, these blue masses will be seen scattered among the meshes of the fibrous tissue. With reference to the discovery of animal starch, see *American Journal of the Medical Sciences*, Oct. 1857, page 203.

† *Moniteur de Hôpitaux*, April 14th, 1857; also, *American Journal of Medical Sciences*, July, 1857, page 203.

8.266 ; chlorides of sodium, potassium, calcium and magnesium, sulphates of soda, potassa, lime and magnesia, phosphates of soda and potassa, 5.733 ; organic matters, animalcules, microscopic plants, decaying animal and vegetable matters, urea, uric acid, salts of ammonia, crenic, apocrenic and humic acids, 15.101 ; silicates of alumina, potassa and lime, silicic acid, peroxide of iron, 56.892. Gases.—Sulphureted hydrogen, 3.488 ; sulphur, 3.283 ; hydrogen, 205 ; phosphoreted hydrogen, carbureted hydrogen, carbonic acid gas, carbonic oxide gas, atmospheric air, oxygen, nitrogen, and other gases. Solid residue, 23.400 ; carbonate of lime, 3.122 ; lime, 1.487 ; carbonic acid, 1.635 ; carbonate of magnesia, 0.455 ; magnesia, 0.217 ; carbonic acid, 0.238 ; chlorides sodium and potassium, 2.946 ; sodium and potassium, 1.350 ; chlorine, 1.596 ; sulphates soda and potassa, 4.223 ; soda and potassa, 2,050 ; sulphuric acid, 2.173 ; silicic acid, 0.213 ; phosphates of soda, potassa, lime and magnesia, trace ; chlorides of magnesium, calcium and aluminum, trace ; organic matters, humic, ulmic, crenic and apocrenic acids, animalcules, microscopic plants, ammonia, urea, uric acid, urate of ammonia, 2.450 ; putrefying vegetable and animal matters, undefined vegetable and animal matters.

We thus demonstrated in 1860 the poisonous nature of the waters of swamps and their power to produce fever and dysentery in living animals when injected subcutaneously.

During the treatment of 6311 cases of disease in the wards of the Charity Hospital of New Orleans, 1869–1886, nearly one-half of which were caused by the action of malaria, I have sought to investigate the proximate cause of the first and subsequent attacks. A large number of the cases of malarial fever and of acute and chronic dysentery and diarrhœa can be traced to the drinking of swamp water and the waters of sluggish bayous and streams, and of wells sunk in low malarious regions.

In the month of October, 1880, during a personal inspection of the cases of Oriental leprosy along the banks of the Bayou Lafourche, I was accompanied by my son, Stanhope Jones, at that time a cadet of the State University of Baton Rouge (now doctor and assistant coroner). The water of the Bayou Lafourche (all that could be obtained for drinking purposes) produced a succession of violent hemorrhages from the bowels of my son, and had I not reached Lockport at midnight and secured the kind assistance of physicians and friends and the necessary remedies, death would have been inevitable. A large number of ulcers of the lower extremities treated in my wards in the Charity Hospital have been traced to the action of the poisonous waters of the swamps and rice fields of Louisiana; and at the present time, November, 1886, I have under treatment a case of extensive ulceration of both lower extremities, complicated with anæmia, jaundice, enlarged liver, enlarged spleen and fever, occurring in the case of a man who had been cutting cypress logs in the swamps near Plaquemine, Louisiana. In dealing with such ulcers, the local treatment will not avail unless the constitutional treatment at the same time be carried on against the malarial fever and its effects. During my labors among the rice and cotton plantations of Georgia, in 1860, I was led to draw up the following rules with reference to the use of the waters and the general conduct of the laborers.

*Waters of the Wells and Springs of the First Tertiary Plain.**—The character of the waters of the springs and wells of the low lands bordering the sea, of Georgia, will depend upon the depth and character of the soil and their distance from the rivers and swamps. The springs and wells of water in sandy formations are of great purity, and their composition is correctly represented in analysis forty-one of Walthourville branch waters. In many of these springs and wells which are formed by the waters percolating through sand beds, which serve the purpose of natural filters, the saline matters are often not more than from one to three grains in the gallon. The waters of low,

* "First Report to the Cotton Planters' Convention of Georgia," etc., by Joseph Jones, M.D., Augusta, Georgia, 1860, pp. 285–289.

swampy lands and rice fields, on the other hand, are impregnated with organic matters which, in certain seasons and under certain conditions, exert most deleterious effects upon the health of the inhabitants. The great mortality upon rice places, many of which actually decrease instead of increasing, is due to the character of the waters, which induce bowel affections and derangement of the blood and low grades of fever. The relations of malarial fever to the organic matters of drinking waters demand a most searching and extensive investigation, and without hazarding an opinion at this stage of the investigation, we would simply state that we have been engaged in an examination of this complicated question as well as of the character and causes of these diseases of rice plantations, and hope to present a special report at some future day. Upon the present occasion I will point out a few practical rules which I know, by experience, will greatly ameliorate the condition of the inhabitants of rice plantations:—

1. Substitute cistern water for well and spring water. If this report should accomplish no other result than the introduction of cisterns upon rice plantations and in the tertiary lime formation of Georgia, I shall feel myself to be rewarded for my labors. The surface exposed by the cotton gins, sheds and barns and dwelling houses upon plantations will prove amply sufficient for the collection of an abundant supply of water.

2. If the cistern water should at any time fail, or if it be impossible to obtain the cistern water, then collect the well and spring water into large barrels or tanks, and add to the mass of water a solution of common alum. One pound of alum pulverized and dissolved in four gallons of water will be sufficient to purify the drinking water of a large plantation for six months. Of this solution a wineglassful may be added to every fifty gallons of water. The alum coagulates the organic matters, they settle and leave a clear, sparkling, wholesome water. The minute proportion of alum in the water will exert no injurious effects whatever; it will be only tonic in its action.

3. Never commence work in the fields and low grounds before sunrise.

4. Never allow the laborers to commence work upon empty stomachs. Establish a law, as unalterable as those of the Medes and Persians, that no one shall leave the quarters without having first cooked and eaten breakfast. Breathing in the morning in an atmosphere loaded with the noxious vapors of the swamps is the most fruitful of all sources of disease.

5. Avoid, as far as possible, the dews of the mornings and nights.

6. Avoid wet clothes, as far as possible.

7. Clothe the feeble, during the fall and winter, in red flannel, worn next to the skin.

8. Treat diseases of rice plantations and low grounds upon the stimulant plan. Avoid all depletion as far as possible, and in the climate fevers administer sulphate of quinia boldly, regardless of the symptoms of headache and delirium; for this is the great remedy in the diseases of swamps and rice fields, even in the pleurisy and pneumonia of the winter season, for they are, in this section of the country, modified by the slow action of malaria upon the system.

9. Do not attribute the diseases of children in the summer and fall to worms. At this period of the year, when children are most liable to climate fever, it is the habit of so many planters to dose them with various drastic and disgusting mixtures, to rid them of worms, under the idea that the worms are the cause of the fevers of this season of the year, because, when the children are taken sick, the worms travel away from them through every avenue and in every direction. The explanation of this striking phenomenon, which, upon a superficial view, is liable to be taken for the disease, is simply this: during the attack of climate fever the secretions of the liver, and of the whole intestinal canal, are so altered that the worms, which have been quietly housed all winter in comfortable quarters, without exciting any injurious effects upon the

unconscious landlords, are suddenly sickened and disgusted with their altered fare and habitations, and beat a precipitate retreat in the most convenient and natural directions.

If you treat the disease for worms alone, the real disease, climate fever, will march steadily on, and you may purge the child until the last worm is evacuated, and only hasten the fatal end, because you are working in conjunction with the disease, all the tendencies of which are depressing. If, on the other hand, you administer a gentle purgative mixed with a full dose of sulphate of quinia, and follow up with gentle stimulants and sulphate of quinia, the termination of almost every case will be favorable, and that, too, in a few days. We are persuaded that strict attention to these simple rules will be the means of materially diminishing the diseases and the rate of mortality upon rice plantations.

*Quinine as a Preventive of Malarial Fever.**—The following observations have lost none of their interest or value by the course of events; in fact, such inquiries are rendered more valuable than ever by the changes wrought by the war in the labor system of the South. The Southern States must do all in their power to promote and foster white immigration, and all facts are of interest which bear upon the health of white laborers in the cultivation of the rich swamps and rice lands, which in many places are now lying idle and rapidly reverting back to their original state. At the commencement of the recent war I prepared and published an article in the *Southern Medical and Surgical Journal*, entitled "Sulphate of Quinia administered in small doses during health, the best means of preventing Chills and Fever, and Bilious Fever, and Congestive Fever, in those exposed to the unhealthy climate of the rich low lands and swamps of the Southern Confederacy." Owing to the state of the country at the time, this publication was not circulated in the manner designed. The climate of the rich, low plain, clothed with a luxuriant, sub-tropical vegetation, which forms a belt along the Atlantic Ocean and Gulf of Mexico of varying width, from thirty to a hundred miles, and which is intersected with numerous swamps, which discharge their waters into sluggish, muddy streams, surrounded on all sides by extensive swamps and marshes, is, necessarily, hostile to the white race. To the pestilential exhalations of stagnant swamps and rich river deposits, excited and disseminated by the burning rays of the sun in this hot climate during the summer and fall months, no process of acclimation has ever accustomed the white man. In the early settlement of South Carolina and Georgia, the inhabitants, in most instances, resided the whole year upon their rich rice and indigo plantations. Many, however, soon fell victims to the climate or dragged out a miserable existence, with constitutions broken and rendered prematurely old by repeated attacks of climate fever. The clearing of the forests, of the swamps and rich low lands, and the consequent exposure to the sun of the vegetable matter which had been accumulating for ages, rendered the climate so deleterious to the white race that the planters were compelled to seek health during the summer and fall months in sea islands, or in pine barren or mountainous retreats; and with the most efficient precautions the mortality of these regions is far greater than in the elevated portions of the Southern States.

The preceding statement has been fully illustrated in the fourth chapter of the present (second) volume of the "Medical and Surgical Memoirs," by reference to the mortuary records of Midway Congregational Church, of Liberty County, Georgia, and by the experience of the British officers in Africa.

The facts which have now been fully presented are sufficient to justify the attempt to devise some means to ward off the climate fever. During the study of the relations of

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* "Quinine as a Prophylactic against Malarial Fever," being an appendix to the "Third Report on Typhoid and Malarial Fevers," delivered to the Surgeon-general of the late C. S. A., August, 1864. By Joseph Jones, M.D.

climate and soil to disease, the collection of the mortuary statistics and the investigation of the causes of diseases upon rice and cotton plantations, and during the discharge of the duties of chemist to the Cotton Planters' Convention of Georgia, the author has, necessarily, been greatly exposed to the agents which produce climate fever, and the results of his experience, now presented, cannot, therefore, be said to be wanting the test of actual experiment. Under these exposures, I have found the sulphate of quinia, taken in from three to five grains twice during the day, would, in most cases, prevent the occurrence of malarial fever, and if it failed to ward it off entirely, the attack would be of a very slight character. I have further observed that when the climate fever first appeared—with a sense of lassitude, headache and excitement of the pulse, with alternate flushings, it might be arrested by a dose of from five to ten grains of sulphate of quinia, in combination with bicarbonate of potassa and Hoffman's anodyne. From five to ten grains of the sulphate of quinia may be given, according to the urgency of the symptoms, united with fifteen grains of bicarbonate of potassa and two fluid drachms of Hoffman's anodyne, from five to fifteen grains of gum camphor; the whole to be dissolved in six fluid drachms of water. The feet should be placed in hot water immediately after or before the administration of the remedies, and the patient, after this bath, should be covered up in bed, so as to promote free perspiration and induce quiet sleep. I have frequently gone to bed in a feverish, restless state, with a severe headache, excited pulse, and pain in the limbs, and dry, warm skin, and, under the action of these remedies, arose in the morning refreshed and able to resume active operations. The bicarbonate of potash is here recommended instead of the proto-carbonate (salts of tartar), which is in such common use during fever in the Southern country, because it is far less active in its effects upon the stomach, and may be taken in much larger doses, and accomplishes more effectually the neutralization of the acid which is so often abundant in the stomach at the commencement of malarial fever, and more effectually acts upon the liver and kidneys, and promotes the removal of all offending matters from the blood.

We would recommend the use of quinia as a preventive of climate fever in the following manner:—

℞	Sulphate of quinia.....	gr. iij
	Dilute aromatic sulphuric acid.....	drops, v
	Brandy.....	tablespoonful, j
	Water.....	wineglassful, ij.

Drop the diluted aromatic sulphuric acid upon the sulphate of quinia, and then add the brandy and water. Administer twice during the day, after rising in the morning and just before bedtime.

To render the value of this means of warding off climate fever still more evident, we have cited in the fourth chapter the practice and success of the British surgeons upon the coast of Africa, premising at the outset, that the epidemic climate fever of Africa does not differ in any essential manner, except, perhaps in its severity, either in its causes, symptoms or effects, from the malarial fever of North America. The value of sulphate of quinia in warding off the climate fever of Africa, has been determined by instituting a comparison between the effects of the disease before and after the use of this medicine as a prophylactic. It is worthy of notice that in the instances in which the author has quoted from the experience of the British surgeons serving in Africa, when quinine wine was administered according to the instructions issued with it, no fever of any consequence followed exposure to land or swamp miasma; but, on two occasions, when quinine purchased on the coast was substituted, and once when the wine was suddenly discontinued after the exposure, a considerable number of men were attacked, owing, it is to be supposed, to the discontinuance of the quinine

After the illustration of the effects of the malarial poison in altering the physical and chemical constitution of the blood and in inducing dropsy, by elaborate chemical analyses and by the detailed reports of cases, we thus formulated the general results.

1. *In malarial fever the specific gravity of the blood and serum is diminished.* The specific gravity of the blood in this disease ranges from 1030.5 to 1042.4, and the specific gravity of the serum from 1018.0 to 1023.6. In health, on the other hand, the specific gravity of the blood ranges from 1055 to 1063, and the specific gravity of the serum from 1027 to 1032.

2. *In malarial fever the colored blood corpuscles are greatly diminished.* In health the dried blood corpuscles may vary from 120 to 150 parts in the 1000 of blood, and the moist blood corpuscles from 480 to 600. In malarial fever, on the other hand, the dried blood corpuscles range from 51.98 to 107.81, and the moist blood corpuscles from 207 to 323.63.

The careful comparison of these analyses of malarial blood with each other reveals the fact that the extent and rapidity of the diminution of the colored corpuscles corresponds to the severity and duration of the disease.

A short but violent attack of congestive or remittent fever in its severest forms will accomplish as great a diminution of the colored blood corpuscles as a long attack of intermittent fever or the prolonged action of the malarial poison.

3. *In malarial fever the relation between the colored corpuscles and liquor sanguinis is deranged.* Thus, in healthy blood the relative proportion of moist blood corpuscles in the 1000 parts, and of liquor sanguinis, may vary from 480.00 to 600.00 of the former, and from 520.00 to 400.00 of the latter; while in malarial fever the globules vary from 207.92 to 323.63, and the liquor sanguinis from 792.08 to 676.37.

4. *The fibrin of the blood is diminished to a marked extent in most cases of malarial fever, and is altered in its properties and in its relations to the other elements of the blood, and to the blood vessels.*

5. *The organic matter of the liquor sanguinis, and especially the albumen, is diminished in malarial fever.* Thus the solid matters of the serum may vary in health from 90.00 to 105.00; while in malarial fever they vary from 62.78 to 80.22 parts in the 1000 parts of blood.

It is chiefly to this latter change, namely, the diminution of the blood in malarial fever, that dropsical effusions are to be traced.

The other changes of the blood without doubt lead to congestions of the liver and spleen and to derangements of the capillary circulation and nutrition of the organs and tissues; but a careful examination of three diseases, as anæmia, chorea and pyæmia, in which the colored blood corpuscles are greatly diminished, will show that this cause alone will not induce dropsy.

In the watery state of the blood induced by the action of the paludal poison, comparatively slight obstructions of the circulation in the spleen and liver might lead to dropsical effusions. It would appear also that from the derangement of the circulation caused by the retention of the malarial poison in the blood and nervous system, certain effete products are not sufficiently and properly eliminated from them, as, for instance, urea, and may be active in the production of dropsy. *New Orleans Journal of Medicine*, July, 1870, pp. 498-500.

During the past 18 years, 1879–1887, I have repeatedly demonstrated to the medical students of the University of Louisiana, in the wards, amphitheatre and dead-house, the diagnostic characters which distinguish the blood of malarial fever from that of yellow fever and other diseases, and have from time to time made permanent record of various portions of our labors in the medical press. *

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* See Memoirs: "Outline on Hospital Gangrene," etc. *New Orleans Journal of Medicine,*

The service as President of the Board of Health of the State of Louisiana, 1880–'84, necessitated the careful and scientific examination of subjects relating to the nature, causation and control of yellow and malarial fevers; and certain questions arising during the progress of medico-legal investigations also required the thorough and continuous use of the microscope in the determination of the physical and minute characters of human blood in health and disease.

During his service as President of the Board of Health of the State of Louisiana during these four years, extending from April, 1880, to March, 1884, the author was enabled to put to the crucial test the actual application of every principle relative to the nature and exclusion of foreign pestilence.

During the period specified the means instituted were effective in excluding yellow fever from the Mississippi Valley; and the principle of diagnosis based upon his clinical and pathological researches gave precision and confidence to the official decisions of the Board of Health, and prevented panic, alarm and useless quarantine.*

January, 1869, Vol. XXII, pp. 22–49; April, 1869, pp. 201–234. "Leucocythæmia or Leukæmia" (white cell blood or white blood). Outline of clinical lecture delivered in the Charity Hospital by Joseph Jones, M. D. *New Orleans Journal of Medicine*, July, 1869, pp. 425–438. "Heart-clot." Outline of clinical lecture delivered at the Charity Hospital, New Orleans, La., by Joseph Jones, M. D., *New Orleans Journal of Medicine*, July, 1869, pp. 469–487. "Memoranda of Medical Clinic, at Charity Hospital, New Orleans, 1869 and 1870," by Joseph Jones, M. D. Sect. 1st: "Diseases of the Nervous System." *New Orleans Journal of Medicine*, April, 1870, pp. 233–274. Sect. 2d: "Dropsy considered as a symptom of various diseases." *New Orleans Journal of Medicine*, July, 1870, pp. 484–563. "Contributions to the Natural History of Yellow Fever," by Joseph Jones, M. D. *New Orleans Medical and Surgical Journal*, January, 1874, Vol. I, New Series, pp. 466–516. "Contribution on Changes of the Blood in Yellow Fever," by Jos. Jones, M. D. *New Orleans Medical and Surgical Journal*, September, 1874, pp. 177–266. "Black Vomit of Yellow Fever," by Joseph Jones, M. D. *New Orleans Medical and Surgical Journal*, September, 1876, pp. 159–165. "Malarial Hæmaturia; Nature, History and Treatment; illustrated by cases," by Joseph Jones, M. D. *New Orleans Medical and Surgical Journal*, February, 1878, pp. 573–591. "Medico-legal evidence relating to the detection of human blood, presenting the alterations characteristic of malarial fever on the clothing of a man accused of the murder of Narcisse Arrieux, December 26th, 1876, near Donaldsonville, La.," by Joseph Jones, M. D. *New Orleans Medical and Surgical Journal*, August, 1878, pp. 101–123. "Yellow Fever Epidemic of 1878 in New Orleans, La.," by Joseph Jones, M. D. *New Orleans Medical and Surgical Journal*, March, 1879, pp. 683–715; April, 1879, pp. 703–780; May, 1879, pp. 850–872; June, 1879, pp. 942–971. "Comparative Pathology of Malarial and Yellow Fevers," by Joseph Jones, M. D. *Transactions* of the Louisiana State Medical Society, Annual Session of 1879, *New Orleans Medical and Surgical Journal*, Vol. VII, New Series, July, 1879, pp. 106–217, p. 297. "Treatment of Yellow Fever," by Joseph Jones, M. D. *New Orleans Medical and Surgical Journal*, September, 1879, pp. 344–365. "Medical and Surgical Memoirs," by Joseph Jones, M.D., New Orleans, La., 1876, p. 826; Vol. II, 1887, p. 1348.

* "Annual Reports of the Board of Health of the State of Louisiana to the General Assembly, 1880–'83," Joseph Jones, M.D., President. "Quarantine and sanitary operations of the Board of Health of the State of Louisiana during the years 1880–'83," by Joseph Jones, M.D., p. 377, New Orleans, 1884. "Measures for the prevention and arrest of contagious and infectious diseases, including smallpox and yellow fever," by Joseph Jones, M.D., New Orleans, Louisiana, 1884.

APPLICATION OF THE RESULTS OF HIS CHEMICAL, MICROSCOPICAL AND PATHOLOGICAL INVESTIGATIONS AS TO THE CHANGES OF THE BLOOD AND ORGANS IN THE VARIOUS FORMS OF MALARIAL PAROXYSMAL FEVER, TO MEDICAL DIAGNOSIS AND MEDICAL JURISPRUDENCE.

If it be true that the malarial poison produces distinct and specific microscopical changes in the blood of human beings, it is evident that we have in such changes valuable data for diagnosis.

It will be admitted, by experienced and competent observers, that medico-legal investigations furnish the most difficult and important opportunities for the crucial test of the nature and value of changes of the human blood under the action of certain poisons, and in certain casualties, as revealed by chemical and microscopical analysis.

The author, in the discharge of certain responsible duties imposed upon him by the legal authorities of Louisiana, was compelled to record his observations upon the changes of the blood in malarial fever.

As far as our information extends, this is the only case in which the pathological changes of the blood found upon the garments of a man charged with the crime of murder was determined and announced officially, in advance of any knowledge of the history and condition of the murdered man.

Regarding this subject as of importance to medical as well as to legal science, we reproduce it.

MEDICO-LEGAL EVIDENCE RELATING TO THE DETECTION OF HUMAN BLOOD, PRESENTING THE ALTERATIONS CHARACTERISTIC OF MALARIAL FEVER, ON THE CLOTHING OF A MAN ACCUSED OF MURDER.*

The value of life and property in every country depends not merely upon the number and character of its laws, but chiefly upon a learned and incorruptible judiciary, supported by an intelligent, law-abiding and virtuous people. The great ends of good government, the security of life, liberty, property, and the pursuit of happiness to all alike, irrespective of birth, condition or occupation, can be secured solely by the impartial administration of just laws and the certain and prompt punishment of their infraction.

Holding these views, the writer has upon various occasions, in several Southern States, responded to the calls of outraged humanity and offended justice, and assumed the painful and responsible task of instituting those post-mortem examinations and chemical and microscopical processes which could best detect and reveal the modes and causes of death, and thus aid justice by furnishing an important link of evidence. Although, during the past twenty years I have been engaged in the investigation of over fifty cases of poisoning by various agents, as arsenious acid (arsenic), strychnia, morphia, opium and its preparations, lead and its salts, sulphate of iron, cyanide of potassium, the seeds of the Jamestown weed and other poisons, and although these medico-legal investigations have resulted in the conviction of a number of criminals; as the processes employed were similar to those practiced by experienced toxicologists, and as the facts, as a general rule, are well known and carefully recorded, I have refrained from burdening the current medical literature with the details. I am induced, however, to publish the following details, under the belief that they will prove of interest to those who may conduct similar examinations, and also in two particulars to the medical profession generally.

The phenomena manifested by the deceased after the reception of the blows upon the head, as well as the detection of the peculiar effects of malarial fever upon the blood spattered on the clothing of the accused, and also upon the floor, walls and fur-

* The *New Orleans Medical and Surgical Journal*, August, 1878, pp. 139–156.

niture of the room in which the murder was committed, appear to be worthy of record and consideration.

Circumstances of the Murder.—Narcisse Arrieux was found, on the morning of December 28th, 1876, dead in his store, situated on the banks of the Mississippi, near the southwestern border of the town of Donaldsonville, Louisiana. The head, face, beard and clothing of the old man, Narcisse Arrieux, were covered with clotted blood. It was evident, from an extensive compound comminuted fracture of the cranium, extending on the right side from the occiput across the right parietal bone and frontal bone to the internal canthus of the left eye, and from several other contused wounds on the head, that death had been caused by blows inflicted by heavy blunt instruments.

The small house occupied by Narcisse Arrieux as a store and dwelling contained three apartments. The largest apartment, which faced the Mississippi river and opened by a door upon the common road or highway leading up and down the road behind the broad levee which protects this region from overflow, was used as a store for the sale and barter of various kinds of merchandise, food and spirits. This store was divided into two unequal portions by a counter running directly across in front of the door ; the space behind the counter was much less in area than that in front.

Back of the counter and communicating with the main room or store were two smaller rooms, one of which was used as a sleeping apartment and the other as an office and sitting room. According to the testimony of the coroner and other witnesses, the dead body of Narcisse Arrieux was found, on the morning of the 28th of December, 1876, lying near the stove, on an overturned chair in the small office. The doors communicating between the store and the sleeping room and office, and between this office and the sleeping room, were open. The door opening from the street into the public road was shut and locked. A pool of blood lay on the floor behind the counter, near a barrel of alcoholic spirits. Traces of blood were also found upon the floor of the store, and marks of bloody hands were also upon the walls and upon the front door, and upon the floor of the office and sleeping room. Marks of bloody hands were found upon the walls and door posts and upon the bed.

Blood was also found upon two desks and in the drawers, in which the deceased kept his money and books. Several four-pound iron weights containing blood and the gray hairs of the deceased were found behind the counter, in the office and sleeping apartment. One of these heavy iron weights, thrown at the head of the deceased, had crashed through a window in the back part of the sleeping room, and was picked up in the yard. According to the statement of Dr. John E. Duffel, an intelligent and accomplished physician of Donaldsonville, who held the post-mortem at the Coroner's inquest, the wounds observed upon the head of Narcisse Arrieux were as follows :—

Left Side.—Contused wound about one-half inch in length, near inner canthus of left eye. Contused wound one-half inch in length, at root of nose on the left side, penetrating and fracturing the frontal bone. Great ecchymosis of both eyes. Contused wound over left eye, but extending diagonally toward the left temple, penetrating to the bone ; contused wound in left temple, in line with margin of left eye. Contused wound on posterior part of the head, penetrating to the bone. Contused wound four inches from left ear, extending backward toward occiput, two inches, fracturing and depressing the occipital bone.

Right Side.—Contused wound on forehead, penetrating to the bone, about three inches across the root of the nose. Contused wound about one inch to the left of the ear penetrating to the bone. Contused wound starting from the outer margin of the eyebrows, ranging downward toward the temporal bone, about three inches in length, ending in a line with the top of the right ear, penetrating, fracturing and depressing the right temporal bone.

Scalp Removed.—Extensive fracture, extending from the inner canthus of left eye,

upward, in a curve, and ranging across the right side of the frontal bone, and around, across the temporal and parietal bones to the occiput. It appears, from the condition of the premises at the time of the inquest, that, notwithstanding the extensive wounds and fractures of the cranium, the deceased, after the infliction of the injuries and after the flight of the assassins and robbers, had partially regained his senses and the use of his limbs; had closed his door, examined his money drawers, had attempted to light a fire in his stove, had placed a newspaper on the floor, unbuttoned and pulled down his pantaloons and evacuated his bowels, had staggered around the walls, steadying himself with his bloody hands, and after seating himself on a chair had died and fallen upon the floor, overturning the chair and lying upon the floor with his legs bent. He appears to have died in the sitting posture, and after death, and even after the establishment of the rigor mortis, the body had fallen upon the floor. It appears, from the testimony, that between the hours of 9 and 11 o'clock P.M., on the night of the 27th (a dark and stormy night), four powerful, stalwart negro men entered the store of Narcisse Arrieux and called for ardent spirits. As the old man turned his back to draw the liquor from the barrel, he was struck by one or more of the robbers, with a four-pound iron weight, on the back of the head. This blow not having the effect desired by the assassins, the weights upon the counter were hurled in rapid succession against his head. The powerful leader of the robbers sprang over the counter and inflicted repeated blows upon his head with a short hickory stick armed with a leaden head, which had been carried concealed in the sleeve of his coat. It is probable that the victim lay unconscious during the robbery of the store, and after the assassins had withdrawn, the profuse hemorrhage (as shown by the large pool of blood behind the counter where he fell) relieved the congestion of the brain temporarily, and upon the return of consciousness he was able to stagger to the door and close it, and to visit his office and sleeping room, and even to examine the desks in which he kept his money and books.

Prosecution of the Accused by the State.—Certain parties suspected of the murder were arrested; four negro men were incarcerated in the city jail charged with the murder of Narcisse Arrieux. Spots of blood were observed by the sheriff upon the coat of Wilson Childers, a powerful negro man, who was known to have been at the store of Narcisse Arrieux on the night of the 27th. Upon his arrest, on the 28th, Wilson Childers affirmed that these spots on his coat were caused by red paint, which was rubbed off from a barrel of whisky which he had handled for a merchant. By the order of the court an examination of these spots was made by physicians and druggists in Donaldsonville, on or about the 29th of December, 1876.

There being no microscope of sufficient power in the town and its vicinity, the court ordered Mr. T. A. Landry to proceed to New Orleans with portions of the coat and shirt of the accused Wilson Childers, and to secure the services of a competent chemist and microscopist for their careful and thorough analysis. Early on the morning of January 2d, 1877, I received the following note from Dr. B. F. Gaudet, late President of the Board of Health, State of Louisiana:—

NEW ORLEANS, January 2d, 1877.

JOSEPH JONES, M.D., Professor of Chemistry, Medical Department, University of Louisiana, New Orleans.

Dear Doctor:—Mr. T. A. Landry, of the Parish of Ascension, has been appointed custodian of a sealed package containing three pieces of woolen stuff cut from the coat of one Wilson Childers, accused of having, on Wednesday, 27th December, 1876, murdered a man, and he was ordered to proceed to New Orleans to submit the above to a chemist and microscopist of well-known reputation, for analysis and examination. The report must be officially made to the Judge of the Parish. I have, of course, suggested your name. You know that you must first take the oath before a Justice of the peace, and swear to the report which you will prepare.

Very respectfully, your obedient servant,

T. B. GAUDET.

Result of Chemical and Microscopical Examination of Stains on the Coat and Shirt of Wilson Childers.—Upon careful chemical and microscopical analysis and examination, I determined that the stains on the coat and shirt of the accused were not paint, but were human blood.

I also determined the fact that the blood was that of a human being who had suffered and was probably suffering at the moment when the blood was abstracted, with malarial or paroxysmal fever.

My written statement of the general result of the chemical and microscopical analysis and examination, sworn to before a Justice of the peace, together with the pieces of cloth, carefully sealed, were forwarded, through Mr. T. A. Landry, to the Honorable Court, Fourth Judicial District, State of Louisiana. I did not introduce into this statement any allusion to the pathological state of the blood, but simply announced these results, namely:—

1. That the stains were not due to red paint nor to any form of paint.
2. That the stains were blood.
3. That the blood presented all the characteristics of human blood.

I informed Mr. Landry, however, of the conclusion to which I had arrived, that the blood was that of a human being who had suffered and was suffering at the moment of its abstraction, with malarial or paludal fever.

On the 29th of June, 1877, I received a peremptory summons to appear in person in the Fourth Judicial District Court, Ascension Parish, State of Louisiana, signed by the Honorable M. Marks, Judge. I repaired forthwith, by steamer and railroad, to Donaldsonville, and found that the Honorable Court had continued the case. Subsequently, I was furnished, by John H. Ilsley, attorney-at-law, with pieces of wood stained with blood, cut from the drawers which contained the money of Narcisse Arrieux.

Chemical and microscopical analysis showed that this blood, which was beyond a doubt that of the deceased, presented the same pathological change as that found on the shirt and coat of Wilson Childers, the accused.

After the examination, the particles of wood were carefully preserved about my person.

On the 27th of May, 1878, I received at the hands of the Deputy Sheriff, in the city of New Orleans, the following:—

The State of Louisianna *vs.* Wilson Childers, *et al.*

THE STATE OF LOUISIANA, PARISH OF ASCENSION, 4TH JUDICIAL DISTRICT COURT.

To DR. JOSEPH JONES:—

You are hereby summoned, in the name of the State of Louisiana, to appear before the 4th Judicial District Court of the Parish of Ascension, on the 29th day of May, in the year of our Lord 1878, at 10 o'clock, A. M., to testify the truth, according to your knowledge, in a certain case now pending before this Court, in which the State of Louisiana is plaintiff, and Wilson Childers, *et al,* is defendant; and hereof fail not, under penalty of the Law.

Witness the Honorable H. D. Duffel, Judge of said Court, 23d day of May, 1878.

L. E. BENTLEY, *Clerk of said Court.*

In accordance with this summons, I appeared in the 4th District Court, Parish of Ascension, Wednesday, May 29th, but I was not placed upon the witness stand until 9 o'clock, Friday night, May 31st. Through the courtesy of the accomplished clerk of the court, Mr. L. E. Bentley, I was furnished with the following report of my testimony as elicited by the examination of the State, represented by D. B. Earhart, District Attorney, and R. N. Sims, Edward N. Pugh and John H. Ilsley, Jr., Attorneys-at-Law, and of the defence as conducted by Col. Winchester, of St. James. In the following report, the questions propounded by the State as plaintiff are indicated by the letter S, those by the defence, for the prisoner, by the letter D, and the answers which

I returned relating to the chemical and microscopical examination of the blood found upon the clothing of the prisoner, in the house of Mr. Narcisse Arrieux, by the letter J. The counsel for the State, after a minute examination as to the time which I had practiced medicine, and devoted special attention to the chemical and microscopical examination of the blood of animals and man, proceeded:—

Examination on Part of State of Louisiana.—S.—Was a sealed package, containing particles of a coat and shirt, at any time delivered to you officially by this Court for chemical analysis and microscopical examination?

J.—On or about the 2d of January, 1877, a small sealed package containing particles or pieces of cloth, was delivered into my hands, with an official warrant for a chemical analysis and microscopical examination, signed by Judge Marks, of this Honorable Court.

S.—Is the following communication to this Court in your handwriting? Is the signature appended yours? If so, read the communication to the Honorable Court.

J.—The report is in my handwriting, and the signature is genuine. The paper reads as follows:—

MEDICAL DEPARTMENT, UNIVERSITY OF LA.,
NEW ORLEANS, January 2d, 1877.

On the 2d of January, 1877, a sealed package was placed in my hands by L. A. Landry, acting under the order of M. O. Marks, Parish Judge, of the Parish of Ascension. Upon breaking the seal, two smaller packages were found, namely, one marked "from left sleeve of coat," containing two pieces of cloth; the other marked "from left breast," containing three pieces of cloth. The said pieces of cloth contained spots of a red and brownish-red color. Careful microscopical and chemical examinations showed that the textures of the cloth in the discolored portions have been saturated with blood. The colored and colorless corpuscles were distinctly seen under a magnifying power of 420 diameters. The colored and colorless corpuscles resembled in size and structure those of man. Hæmatin and albumen were also present in the matters extracted from the discolored spots. JOSEPH JONES, M.D.

Sworn to and subscribed before me, this January 2d, 1877.

W. H. HOLMES, *Second Justice of Peace, Parish of Orleans.*

S.—Did you destroy the pieces of cloth containing the stains during your chemical and microscopical examination, or did you re-deliver them to Mr. Landry, duly sealed?

J.—I carefully preserved the pieces of cloth, and, after sealing them carefully, delivered them to Mr. L. A. Landry, in the presence of Wm. H. Holmes, Second Justice of the Peace, Parish of Orleans.

S.—Can you identify this package, with its seal, direction and contents?

J.—I can; the direction is in my handwriting; the seal is mine; the particles of cloth resemble in all respects those which were delivered to me by Mr. Landry, and which I examined in my laboratory, on or about the 2d of January, 1877.

S.—Did the pieces of cloth, when delivered to you by Mr. Landry, contain any spots, or present anything peculiar?

J.—They did. Each piece of cloth contained spots of a red and reddish-brown color.

S.—Were these spots caused by red paint?

J.—They were not caused by paint of any color or description.

S.—How would you detect spots of paint on any texture, as cloth or clothing?

J.—Paint consists of oil mixed with metallic, earthy or vegetable or animal substances, according to the nature of the paint and the purposes to which it is applied. The oil may be extracted from paint by certain agents, as sulphuric ether and sulphuret of carbon. The oil may be recognized by its physical and chemical properties, and also by the presence of globular masses of various sizes, under the microscope. The coloring matters of paint, under the microscope, as a general rule, present a granular appear-

ance, and in no kind of paint do they resemble the colored blood corpuscles of man and animals. In the case of red paint, some form of the oxide of iron, or the oxide of lead, or the sulphuret of mercury (vermillion) may be used. After the extraction of the oil from the paint by sulphuric ether, these oxides specified may be rendered soluble by the action of the mineral acids, and especially by hydrochloric and nitric acids. The solutions thus obtained may be subjected to several tests. The salts of iron give blue and bluish-green precipitates with ferricyanide and ferrocyanide of potassium, and black with solution of tannic acid, and the per-salts of iron give a brownish-red precipitate with aqua ammonia, and a deep red color with sulpho-cyanide of potassium. If the color of the paint be due either to the oxide or the sulphuret of mercury, after the abstraction of the oil in the manner specified, the metallic mercury may be reduced by heat, or a nitrate, sulphate or chloride formed by the action of the respective acids, and the soluble salt thus formed may be subjected to various reagents, as iodide of potassium (green precipitate with proto-salt of mercury, and red precipitate with per-salt of this metal); lime water and solution of potassa, black precipitate with proto-salt and yellowish red with per-salt; a plate of polished copper plunged in solution of soluble salt of mercury is quickly coated with metallic mercury, which may be removed by sublimation, dissolved in the mineral acids and subjected to the test just specified. If the color be due to the red oxide of lead, the metal may be reduced from the paint by means of the blowpipe; the oxide may also be separated from the oil and subjected to the action of nitric acid, and the solution subjected to the action of various chemical reagents, as iodide of potassium (yellow iodide of lead), chromate of potassa (yellow chromate of lead), sulphureted hydrogen (black sulphuret of lead), sulphuric acid and soluble sulphate of lead (white sulphate of lead).

S —What did you determine these spots to be by chemical and microscopical examination? and state fully to this Honorable Court the ground upon which your statement was based, and the processes by which you arrived at your conclusions.

J.—Chemical and microscopical examination showed the spots to be those of blood. The presence of blood was determined by the following processes and reagents: When the stains were examined in a strong light, with a low power of the microscope, the fibres were not merely colored, but presented a shining, glossy appearance, and the individual fibres were observed to be invested with portions of dried coagulum or clot. Certain chemical processes, as the following, established presumptively that the matter which imparted the color to the spots on the clothing of the accused was blood.

It readily combined with cold distilled water, forming a bright red solution. This color was not changed to a crimson or a green tint by a few drops of a weak solution of ammonia, but when this agent, in concentrated form and large amount, was added, the red liquid acquired a brownish tint. The red liquid obtained from the particles of blood in the textures of the cloth, by means of cold water, coagulated when it was boiled, the color was destroyed and a muddy brown, flocculent precipitate was formed. When the coagulum was collected on a filter and dried, it formed a black resinous substance, quite insoluble in water, but readily dissolved by boiling caustic potash, forming a solution which was of a greenish color by reflected, and reddish by transmitted light. When the solution of the clots in cold water was subjected to the action of strong nitric acid, the red coloring matter of the blood and its albumen were coagulated and a dirty brown precipitate was thrown down. When examined under the microscope with various powers, ranging from 400 to 1800 diameters, the red matter causing red stains was found to consist of numerous circular, disc-like or flattened globules having an average diameter of $\frac{1}{3200}$ of an inch. The white or colorless corpuscles of the blood were also clearly distinguished.

S.—Did you observe anything which would indicate the state of the health of the

individual from whom the blood had issued upon the clothes of the accused? and if so state your observations to this Honorable Court.

J.—I observed changes in the blood obtained from the pieces of cloth which led me to infer that the person from whom it was abstracted had suffered and was most probably at that time suffering with paroxysmal, paludal or malarial fever.

This opinion was based chiefly upon the following abnormal substances observed in connection with the colored and colorless or white blood corpuscles: Black pigment or melanæmic corpuscles, varying from $\frac{1}{10000}$ to $\frac{1}{1000}$ of an inch in diameter; conglomerations of these melanæmic particles, in masses of various sizes; colorless corpuscles or leucocytes which contained small granular masses of black pigment. Many of the particles of the melanæmic pigment were spherical, others irregular and angular, some entirely free, others incased in a hyaline mass; others incorporated with cellular elements which are more or less related to the white corpuscles of the blood. These black pigment particles indicated the destruction or alteration of the blood corpuscles and the escape of the hæmatin of the red globules which is characteristic of malarial fever.

S.—How long have you been engaged in the microscopical and chemical investigation of the blood of man in disease, and upon what facts do you base the preceding statement?

J.—My investigations upon the chemical and microscopical changes of the blood in fevers, and especially in malarial and yellow fevers, were commenced in 1856, and have been pursued continuously up to the present moment; and during the past ten years I have treated, in the wards of the Charity hospital of New Orleans, over four thousand cases of various diseases, more than one-half of which were due to the action of the malaria of the swamps and marshes of the Mississippi valley. The blood in a large number of these cases has been subjected to microscopical and chemical examination, and in fatal cases post-mortem examinations performed. The result of these investigations, which throw light upon the inquiries of this Honorable Court, are as follows:

1. The malarial poison produces profounder alterations and more rapid destruction of the colored blood corpuscles than any other known febrile agent.

2. The destruction of the colored corpuscles takes place chiefly in the spleen and liver.

3. The black pigment resulting from this hæmatin of the blood corpuscles is frequently observed in the blood as it circulates in the vessels and capillaries, in masses of various sizes and in the form of cellular elements.

4. The black pigment is deposited in the capillaries of various organs and tissues, as those of the liver, medulla of the bone, brain and subcutaneous tissue.

5. The peculiar sallow, greenish-yellow and bronzed hue, which characterizes those who have been for a length of time subjected to the prolonged action of the malarial poison or to its powerful action in pernicious remittent fever and in malarial hæmaturia, is due not merely to hepatic and splenic derangement, but also to the deposit of pigment particles in the subcutaneous capillaries.

S.—Did you make any further examinations of blood in this case or in connection with the deceased? If so, state the result.

J.—I examined bits of wood brought to New Orleans, and placed in my hands by John H. Ilsley, attorney-at-law and counsel for the State. These pieces of wood, the one of cedar and the other of mahogany, were spotted and coated upon the smooth side with blood. Microscopical and chemical examination revealed that it was human blood, and human blood presenting similar pathological alterations to that examined on the particles of cloth cut from the coat and shirt of the prisoner, and previously described. The blood, as in the first examination, contained numerous black particles, and pigment cells and colorless corpuscles, containing round, black pigment particles.

Upon arriving in Donaldsonville, through the kindness of Dr. John E. Duffel, I visited the house formerly occupied by the deceased, and found that the particles of wood fitted exactly into the front portions of two drawers belonging to two desks. Undeniable testimony established the fact that the blood on these pieces of wood was that from the deceased after the infliction of the blows on the head.

S.—Have you preserved these pieces of wood? and if you have, produce them before the jury and fit them into the places from whence they were cut, in the drawers, which have been brought to this Court.

J.—I have carefully preserved the pieces of wood upon my person, from their first reception to the present time. They correspond exactly to the missing portions of wood in the drawers exhibited by the State before this Honorable Court.

S.—Have you examined the blood of various animals, as, for instance, reptiles, birds, and domestic animals? And if you have, state the general results of your examinations, and if the blood of these animals can be distinguished from that of man.

J.—I have examined microscopically and chemically the blood of a large number of the indigenous fish, amphiuma, sirens, batrachians, ophidians, saurians, birds and wild mammalia, and also the blood of domestic fowls and animals, and can state that in fish,* amphibians, batrachians, saurians and birds, the blood corpuscles can be distinguished at once and beyond all question under the microscope, on account of the elliptical shape and nucleated centre; but in the case of the domestic and indigenous mammalia a more critical examination is required; for in this class of animals the size of the globules varies within comparatively narrow limits; they have a flattened or disc-like form, and with the exception of the camel tribe, the outline of the disc is circular.

Examination on the part of the Defence.—D.—Are you absolutely certain that the stains on the pieces of cloth placed in your hands for microscopical and chemical analysis were caused by human blood?

J.—The substances causing the stains presented all the chemical and microscopical properties of human blood, and blood presenting a special pathological alteration.

D.—Can you by means of chemical and microscopical examination of the blood determine any form of disease?

J.—By chemical and microscopical examination I am not able to determine every form of disease.

D.—You would then be in doubt concerning the result, in certain diseases, of the chemical and microscopical examination; please state, therefore, if there are any diseases, the nature of which may be revealed by the microscope?

J.—The microscope enables us to distinguish clearly the changes induced in the blood by malarial fever. That condition of the blood known as leucocythæmia or leukæmia can be accurately determined by microscopical examination. There was no doubt in my mind that the blood examined was human blood, from one who had suffered, and perhaps was at the time suffering with malarial fever.

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* The blood discs of fishes are commonly of a full, elliptic shape; they present the largest size in the sharks, but are smaller in them in proportion to the body or mass of blood than in the batrachia. The white corpuscles are in less proportion in the blood of fishes than in saurians, birds or mammals. In my physiological and chemical researches, published by the Smithsonian Institution in 1856, I endeavored to establish the comparison of main physiological importance between the blood in different groups of vertebrates, namely, that which relates to the proportion of the organic matters contained in the water. It was then clearly shown that the blood varied, in the different classes of animals, in physical and chemical properties. The blood of reptiles has red corpuscles of a flattened, sub-biconvex, elliptical shape, proportionally smallest in ophidia, roundest in chelonia, and largest in batrachia. In birds the blood discs are more abundant than in the cold-blooded vertebrates; they are nucleated, elliptic and flattened in form, averaging in size, in long diameter $\frac{1}{2100}$ to $\frac{1}{3300}$ of an inch.

D.—What did you say was the average size of the colored blood corpuscles in the stains upon the cloth? and while giving this measurement, give those also of the dog, horse, rat, cat, rabbit, ass, ox, cow, sheep and goat.

J.—The average of the diameter of the blood corpuscles from the stains, was about $\frac{1}{3200}$ of an inch. The corpuscles of human blood are larger than those of domestic animals. Thus, the average diameter in the dog is about $\frac{1}{3540}$ of an inch; horse, $\frac{1}{4600}$ of an inch; in the rat, $\frac{1}{3814}$ of an inch; in the cat, $\frac{1}{4400}$ of an inch; in the rabbit, $\frac{1}{4000}$ of an inch; in the ass, $\frac{1}{4000}$ of an inch; in the ox, $\frac{1}{4267}$ of an inch; in the cow, $\frac{1}{4200}$ of an inch; in the pig, $\frac{1}{4230}$ of an inch; in the sheep, $\frac{1}{5300}$ of an inch; in the goat, $\frac{1}{6366}$ of an inch.

D.—Do not those individual blood corpuscles in man and animals vary in their diameter in the same specimen of blood? and if so state to the Honorable Court the causes of these variations.

J.—The blood corpuscles of man and animals vary in their diameters within certain limits; thus, those of man may vary from $\frac{1}{2000}$ to $\frac{1}{4000}$; of the dog from $\frac{1}{4000}$ to $\frac{1}{6000}$; of the hare from $\frac{1}{2000}$ to $\frac{1}{8000}$; in the ox from $\frac{1}{4878}$ to $\frac{1}{4444}$; in the sheep from $\frac{1}{5333}$ to $\frac{1}{8000}$ of an inch.

D.—Difficulty, therefore, exists in distinguishing between the blood of man and domestic animals; and in view of this fact do you assert absolutely that the stains in the pieces of cloth were human blood?

J.—I admit that difficulties exist in such examinations. I affirmed that the human blood corpuscles, upon an average, were larger than that of the domestic animals named. I also affirmed that the stains upon the pieces of cloth presented all the characteristics of human blood. I went a step further and affirmed that this blood presented pathological appearances which, as far as my investigations extend, are peculiar to human blood in a certain diseased state, and that I have never observed such a condition in the blood of animals; and that the blood from the house in which the deceased was murdered presented similar chemical and microscopical characters.

D.—Can the colored blood corpuscles be detected with accuracy in dried blood?

J.—They can be detected in many cases; and they were detected accurately in the case now before this Honorable Court.

D.—Can you distinguish between the blood of a woman and the blood of a man?

J.—I cannot.

D.—Can you distinguish the blood of a fœtus from the blood of its mother?

J.—I cannot.

D.—Can you distinguish the blood of the different races of men? for example, can you chemically and microscopically distinguish the blood of a white man from that of a negro?

J.—Different races are said to have distinct odors; sulphuric acid applied to blood will liberate the peculiar odor of the animal; I have, upon many cases, satisfied myself of the possibility of developing the peculiar odor of the blood in different animals by sulphuric acid. I cannot, however, speak positively with reference to the blood of the different races of mankind.

VERDICT OF JURY.

By the testimony of several witnesses, two of whom were practicing physicians, it was clearly established that, for some weeks before and up to the time of his murder, Narcisse Arrieux was suffering with intermittent malarial fever (chills and fever). The judgment of the jury rested, to a great degree, upon the presence of blood on the clothing of the accused, Wilson Childers.

We have been informed by John H. Ilsley, Jr., one of the attorneys for the prosecution, that an important witness testified as to the guilt of the four negroes accused of

the murder of Narcisse Arrieux. The jury rendered the verdict guilty of murder, with capital punishment.

MICROÖRGANISMS OF MALARIAL FEVER.

The microörganisms, which we have observed in the blood of patients suffering from malarial fever may be thus briefly enumerated:—

(*a*) Minute globular bodies, from the ten-thousandth to the thirty-thousandth of an inch in diameter, having the general appearance and chemical characters of the spores of bacteria.

(*b*) Globular bodies of larger size than the preceding, often of a dark, opaque character, found not only in the liquor sanguinis, but also in the colored blood corpuscles and in the colorless blood corpuscles. These bodies, most probably true spores, possess the power of invading and destroying the colored blood corpuscles. These micrococci or spores are often observed in the blood in groups, surrounded by protoplasm, constituting zoogloœa.

(*c*) Ovoid, cylindrical and rose-shaped bodies, not destroyed by acetic acid and stained by aniline dyes. These bodies increase during the cold stage, and are most numerous in pernicious malarial fever.

(*d*) Colorless blood corpuscles containing minute pigment granules, and dark spherical bodies, resembling sporules; many of these pigmented corpuscles or aggregations of dark spherical bodies, surrounded by protoplasm, are about twice the diameter of the colorless blood corpuscles of normal blood; and their behavior under the action of reagents and also during the process of staining, leads to the view that a portion at least of these bodies must be regarded as vegetable organisms. The large pigment cells appear to be characteristic of malarial fever.

(*e*) Masses of hæmatin of various forms, irregular in size and shape, but most generally the sides and portions seen in profile are angular. The deposits of large pigment masses in the brain in malarial fever, and especially in cases of repeated paroxysm, find their origin in the changes of the colored blood corpuscles, induced by the morbific ferment or microörganisms of malarial fever.

There is an actual destruction of the colored blood corpuscles in the living blood, and within the walls of the living capillaries and blood vessels in malarial fever; and this destruction is not referable, either solely or originally, to the action of the bile acids accumulated in the blood, as a consequence of biliary congestion, or obstruction during the febrile stages of malarial fever.

We can detect the process of the disintegration of the colored blood corpuscles by the microscope, and detect the very inception of that great pathological change which constitutes one of the most distinctive features of malarial fever, and which must be carefully considered in any scientific and rational plan of treatment.

(*f*) Marked variations in the size of the colored blood corpuscles.

These variations, from small corpuscles to what may be called giant corpuscles, twice the diameter of normal blood globules, appear to be characteristic of malarial fever.

The destruction of colored blood corpuscles does not take place with equal rapidity in all parts of the organism, but appears to be most marked in the spleen and liver.

The blood pigment resulting from the hæmatin of the blood corpuscles is frequently observed in the blood as it circulates in the vessels and capillaries, in masses of various sizes, and in the form of cellular elements.

Without doubt local congestions may be caused by obstruction of the circulation in the capillaries and by these pigment particles and cells; and such congestions may lead to local hemorrhages. The congestions and hemorrhages thus resulting are especially significant when occurring within the structures of the brain and spinal cord.

The appropriation of a portion of the altered coloring matter (hæmatin of the

colored blood corpuscles), by the leucocytes, is due to the physical and vital endowments of their elementary bodies.

It is now generally admitted that the colorless corpuscles are elementary organisms which are endowed with the power of spontaneous motion, this power belonging to them in virtue of the protoplasm of which these bodies are composed. This motion is of two kinds, the change of form and the change of place; the latter resulting from the former. It has been demonstrated that the colorless blood corpuscles possess the faculty of taking, by virtue of their *amœboid movements*, solid particles into their substance.

This subject is of transcendent importance to the student of fevers, in giving an important point of diagnosis for malarial fever, which distinguishes it from all other forms, and especially from *yellow fever*.

The author demonstrated during the progress of his pathological researches, extending from 1856 to 1887, the power of the colorless corpuscles of human blood to feed upon and appropriate the hæmoglobin, hæmatin and hæmin of the colored blood corpuscles in the blood vessels of malarial patients, before physiologists had experimentally determined by employing either finely divided fatty substances, or coloring matter, the power of the colorless blood corpuscles to take solid particles into their substance.

We have thus traced the pigmentation of the colorless blood corpuscles in malarial fever to—

(*a*) The destruction of the colored blood corpuscles by the morbific ferment, or microörganism of malarial fever.

(*b*) The separation of the hæmoglobin, hæmin and hæmatin, and its appropriation by the colorless blood corpuscles, in virtue of their physical and vital properties and amœboid movements.

(*c*) The invasion of the colorless corpuscles by the colored spores of the malarial microörganisms.

GENERAL RESULTS OF EXPERIMENTS INSTITUTED TO DETERMINE THE NATURE AND RELATIONS OF THE ORGANIC AND LIVING CONSTITUENTS OF THE ATMOSPHERE TO THE MICROSCOPICAL AND CHEMICAL CHANGES OF THE BLOOD IN YELLOW AND MALARIAL FEVERS, DURING THE YELLOW FEVER EPIDEMIC IN NEW ORLEANS, LOUISIANA, 1878.

Relying upon the fact that cold arrests yellow fever, I sought to condense and render palpable to the eye and touch the poison, by passing large volumes of the yellow fever atmosphere of 1878 through ice and ice-cold water, by means of carefully constructed bellows. In this manner I threw from 100,000 to 600,000 cubic centimetres of the yellow fever air of 1878 through ice and ice-cold water. The products of the condensation thus obtained were examined, both chemically and microscopically. The air was taken from rooms in the most infected localities containing those suffering with the various stages of yellow fever.

I also endeavored to determine whether the living particles found in the air differed in accordance with the locality, whether *malarious* or *non-malarious*.* After a thorough examination of the minute spores, micrococci and organic and inorganic matters of the air in which yellow fever was prevailing, it was observed—

(*a*) In the well-paved and well-drained, non-malarious portions of New Orleans, the solid matters of the air examined, not only during the prevalence of the yellow fever,

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* "Yellow Fever Epidemic of 1878, New Orleans," by Joseph Jones, M.D. *New Orleans Medical and Surgical Journal*, March, 1879, pp. 683–715; April, 1879, pp. 763–780; May, 1879, pp. 852–879; June, 1879, pp. 933–942.

but also at various intervals during a period of six to eight months, I discovered no form which could be referred to such microscopical plants as the chlorococcum vulgare, protococcus viridis, palmella cruenta, coccochloris brebinonii and other confervoidæ, or unilocular algæ capable of producing chlorophyl.

Certain granular cells observed in the blood of malarial fever resemble most nearly the resting spore of bulbochæte intermedia, and the granular cells of palmella cruenta; but no such cells were observed in the atmosphere of the houses situated in well-paved and well-drained sections of the city.

The forms of the non-malarial sick rooms (rooms containing yellow fever patients) were referable to those most nearly connected with putrefaction and fermentation, as the bacteria and torulæ, penicillus and micrococci and cryptococcæ.

The absence of any of the known forms of algæ in the air of yellow fever collected in the non-malarious, well-drained and well-paved portions of the city of New Orleans, is important, in that this class of plants is thus excluded from the consideration of the question relating to the origin and causation of yellow fever.

(*b*) The water obtained by passing the air through ice and melting ice and ice-cold water, was preserved, and portions added to solutions of sugar. The water from the rooms in which yellow fever patients lay caused the development in solution of sugar of a delicate fungus, the spores of which were distributed in regular rows, within the thallus. This plant, as well as that developed in the yellow fever blood, assumed a distinct yellow color. Both penicillium and torulæ were observed in these solutions.

For many years we have had, and taught essentially, the following—

THEORY OF THE CAUSATION OF THE PATHOLOGICAL PHENOMENA IN THE LIVING HUMAN BEING, KNOWN AS MALARIAL FEVER.

We are justified by our own observations, as well as those of observers who have recorded *positive* results, in the conclusion that malarial fever is caused by a specific, living, pathogenic microörganism.

This microörganism and its spores exist in the soil, waters and atmosphere of malarial regions. It gains access to the blood of human beings, where it commits its greatest ravages, through the lungs and through the skin and alimentary canal, but it is chiefly through the respired air and the ingested water that it finds the media for its penetration into the capillaries and circulatory fluids.

The condition of the individual at the time of exposure, whether of health or ill-health, and the integrity of the pulmonary, alimentary and cutaneous surfaces, without doubt modify or influence the rapidity of the introduction and the subsequent action of the malarial pathogenic microörganism. After the introduction of the pathogenic microörganisms into the circulation they cause the splitting up of complex nitrogenous compounds (proteids, colloids, as well as crystalloid bodies) into compounds of comparatively low or simple composition; they cause the disintegration of nitrogenous compounds by withdrawing from the compounds certain molecules of nitrogen, building up with these their own protoplasm. Similarly carbohydrates and inorganic salts are dissociated by them, inasmuch as they require a certain amount of carbon, phosphorus and potassium for building up their own bodies. The profound and remarkable changes of the amount and character of the constituents of the blood and urine, which we have detailed in the preceding pages, are thus shown to have their origin in the chemical changes excited by the life acts of the pathogenic malarial microörganism. In this process of decomposition, certain alkaloid bodies, closely related to the ptomaines, are produced and act upon the ganglionic centres of the nervous system, indicating aberrated nervous and muscular action, causing capillary congestion, deranged secretion and other toxic effects. It is probable that in the most malignant cases a compound or compounds resembling the septic poison (sepsin) is one of the products of decompo-

sition of animal substances. It will be readily admitted that putrid intoxication or poisoning may occur as a pyæmic affection in the human subject, when a large ulcerating surface exists, in which it is well known that large numbers of putrefactive organisms are growing and are producing the septic poison or sepsin, which can be isolated by various chemical processes destructive of every living microörganism. Gaspard, Burdon-Sanderson, Panum, Bergmann, Billroth, Guttmann, Semmer and many others, have shown that sepsin injected into the vascular system of animals produces a marked febrile rise of temperature, and is capable of causing death with the symptoms of acute poisoning, showing vomiting and purging, spasms, torpor, collapse and death. On post-mortem there are found changes similar to those observed in the most malignant of fevers, and especially of hemorrhagic malarial fever and yellow fever; namely, severe congestion and hemorrhage of the stomach, duodenum and rectum; hemorrhage in the pleura, lungs, pericardium and endocardium; congestion and hemorrhage in the peritoneum; congestion of the liver; congestion of the kidneys and bloody urine. This *putrid infection* leads to death in twelve to twenty-four hours, or even less. On injecting smaller quantities only a febrile disturbance is noticed, severe symptoms and death only following after injection of considerable quantities, such as several centimetres, of putrid fluid. Thus sepsin is known to be one of the products of the chemical changes excited in nitrogenous bodies by the multiplication, growth and life actions of *septic bacteria.*

By holding that the microörganism of malarial fever develops or produces by its action on the proteid and morphological elements of the blood, bodies related to the animal alkaloids (ptomaines) and to sepsin, we have an explanation of the violent vomitings, sudden hemorrhages and profound coma characteristic of the severest forms of malarial disease. At the same time it should be observed that in the growth and chemical action of certain microörganisms, the products of the decomposition started and maintained by them have a most detrimental influence on themselves, inhibiting their multiplication; in fact, after a certain amount of these products has accumulated, the organisms become arrested in their growth, and finally, may be altogether killed. We have already dwelt upon the importance of the fact that *indol*, *skatol*, *phenol*, and other bodies belonging to the aromatic series, which are produced in the course of putrefaction of proteids, have a most detrimental effect on the life of many microörganisms. While it has not been as yet clearly determined whether in these instances the organisms produce the chemical effect by creating a special zymogen or ferment, and through it causing the chemical disturbance, or whether they merely dissociate the compounds by abstracting for their own use certain molecules ; it is, on the contrary, well established that in consequence of this chemical disturbance definite chemical substances are produced.

In view of the fact that the microörganism of malarial fever acts with greatest energy and most destructive effects upon the colored blood corpuscles; and in view of the fact that there appears to be no practical limit to the alteration and destruction of the red globules; we must refer the temporary cessation of the actions of the microörganism (the intermissions and remissions of malarial fever), not to the exhaustion of any special chemical substance in the blood and organs, but rather to the effects of the elevated temperature and the formation of antiseptic compounds, in arresting the development, and in destroying large numbers of the microörganisms. In certain diseases, as smallpox, vaccinia and typhus fever, the chemical changes resulting from the action of the pathogenic microörganisms, as well as the elevation of temperature, are such as to cause the complete destruction and elimination of the germs originally producing the disease.

In the paroxysms of malarial fever, there is in like manner a destruction and elimination of the pathogenic microörganisms, but in many cases the destruction and elimi-

nation of the germs of the disease is not complete, and these remaining in the blood reproduce their kind, and after a definite period the same phenomena are repeated. The paroxysm of malarial fever, with its elevated temperature and antiseptic products, must, to a certain extent, be regarded as curative in its effects; and it is well established that a considerable number of cases of malarial fever end spontaneously and pass into recovery after one or more paroxysms, without the employment of any antiseptic or any remedies whatever; in such cases the febrile changes excited by the pathogenic organisms have resulted in their death and elimination. On the other hand, the most destructive and incurable forms of malignant anæmia, ending finally in hepatic and splenic enlargement, general anasarca and failure of the heart and nervous centres, often result from the continuous and almost unobserved action of the malarial microörganism upon the constituents of the blood, and, more especially, upon the colored blood corpuscles; in such cases the antiseptic products of high fever have not been formed.

We must look to chemical knowledge to guide us in our contests with the specific agents of malarial and other diseases, and we accept the doctrine, with but slight modification, that no chemical or other agent can be rightly regarded as disinfectants, in respect of any disease, unless it can be shown to have the power of inhibiting or arresting the development and growth of the particular species of microphyte which is the constant concomitant of the morbid process; and that inasmuch as all specific microphytes are endowed with the power of multiplying in the blood and living tissues of the organism they infest, and of there playing their part in the morbid process; all specific disinfectants must, in order to encounter the organisms they are intended to destroy, be of such a nature that they can, without prejudice, be mixed with the circulating blood, and come into direct contact with the tissues.

In the case of malarial fever we have in quinine such a disinfectant, which is not only poisonous to the pathogenic microörganism of malarial fever but is also of such a nature that it can, without prejudice, be mixed with the circulating blood and come into direct contact with the tissues. Quinia may be taken in large doses without danger; it is eliminated slowly, with little or no change, by the skin and kidneys; it circulates freely in the blood, and passes into the organs, and is thus brought into contact with all pathogenic microörganisms; its action as a disinfectant is greatly increased by the rapidity of the circulation, and its action is also favored and supplemented by the antiseptic products developed during the febrile paroxysms. Professor Ceri, of Camerino, has shown that the infecting power of the organisms of malarial soils by the introduction of quinine into the infecting fluids, one part of quinia to 800 of the culture fluids, prevented the development of the malarial spores, and arrested the putrid fermentation induced by them. Administered to healthy men, quinine reduces the urea twenty-five per cent. and the sulphuric acid forty per cent.; it diminishes the amount of uric acid; it slightly increases the amount of water; it does not diminish the amount of carbonic acid excreted by the lungs. The spleen of warm-blooded animals contracts under the influence of quinia within a few hours; it becomes tougher and its surface is thrown into folds; these phenomena are not prevented by the previous section of the afferent nerves. In healthy persons and in most febrile patients, it is not decomposed in passing through the blood, but is entirely excreted by the kidneys and bowels; notwithstanding that it does not directly take part in the chemical changes in the body, it produces giddiness and ringing in the ears, disturbances of hearing and vision, depression of reflex irritability, depression or impairment of the heart's action; diminished frequency of the pulse; diminished arterial pressure, prostration and reduction of animal temperature. Solutions of albumen are converted into peptones if shaken up in an atmosphere of nascent oxygen, but this change is prevented if quinia be present. Even in relatively small quantities it prevents the putrefaction of nitro-

genous substances, as well as several simpler fermentive processes, in both cases it acts directly on the protoplasm of which the substances or their germs are composed. On the other hand it is of importance, in the administration of quinine in large or continuous doses, that other amorphous ferments, such as ptyalin and pepsin, have their properties very slightly or not at all arrested by quinia, and there are several protoplasmatic organisms on which it has no poisonous effects whatever, whereas it reacts on the other with unexpected vigor.

The poisonous action of many putrid fluids upon warm-blooded animals may be neutralized, either completely or as far as certain symptoms are concerned, by the simultaneous administration of quinia. Owing to the energy with which it paralyzes certain kinds of protoplasm, quinia diminishes the absolute number of white blood corpuscles in the body; the lymphatic glands, under its action, become small, and are found, on section, to be abnormally dry, while splenic enlargements, due to hyperplasia of the lymphatic follicles, and to the increased tissue change within the organ by which it is accompanied, are reduced or prevented.

The escape of white blood corpuscles from the vessels, and the suppuration which ensues, can be distinctly limited in animals by quinia; its effect in this instance is, in the main, independent of the condition of actual pressure. It is due to a lowering of the affinity of the corpuscles for the oxygen of the hæmoglobin, this oxygen being the stimulus which excites the independent movements by which emigration from the veins and capillaries is partly effected. Fresh vegetable juices containing protoplasm, and also healthy pus—both of which ordinarily give the reaction of nascent oxygen with tincture of guaiacum or indigo—lose this property when mixed with relatively weak solutions of quinia, this alkaloid preventing the protoplasm from absorbing oxygen from the atmosphere and undergoing the special alteration to which the reaction is due.

Phosphorescent infusoria, or those which are continually undergoing powerful oxidation, completely lose their phosphorescence on the addition of minute quantities of quinia. The addition of quinia to blood which has been recently drawn not only diminishes the physiological production of acid which occurs immediately after its removal from the body, but also its power of transferring active oxygen to oxidizable bodies. This effect also takes place with pure hæmoglobin without its being possible to detect any decomposition of the latter spectroscopically during the presence of the quinia. On the contrary, when blood which contains quinia is heated, the lines which indicate oxygen disappear at a higher temperature than the same lines in pure blood used for comparison. The *penicillium fungus*, when mixed with hæmoglobin outside the body, withdraws oxygen from it, and this process is arrested by quinia.

From the preceding facts, established by the labors of eminent observers, as Dr. C. Binz, Mosler, Boeck, Rossbach and Preyer, and taking into consideration the alterations in size which the red blood corpuscles undergo under its influence, it seems probable that while the quinia renders certain cells within the human organism still less fitted than before for the absorption of oxygen, it binds that element more firmly to the hæmoglobin. The fall of temperature which quinia so frequently produces in fever (0.5°, 4.0°, and more, Centigrade) is independent of the heart, and also of those portions of the nervous system which take origin in the brain and pass downward through the spinal cord; for it still takes place after the cervical portion of the latter has been completely divided; nor does it appear to depend upon an increased omission of heat from the skin. The reduction of temperature appears to be largely due to some inhibitory effect exerted by quinia over the functional activity of the protoplasmatic cells of the heat-producing organs. Even the normal cells become slightly depressed by its action, especially when they are producing an unusual amount of heat under the stimulus of pyretic substances; and those infective poisons (whether they be organized or merely in solution) which are capable of self-multiplication in the body after more or less of a

period of incubation, and of acting as irritants to their cells, are either rendered by quinia incapable of further development, as in malarial fever, or they have their energy paralyzed, as happens, to some extent, in typhoid fever. Quinia essentially differs from chemically allied molecules—such as morphia, strychnia, veratria—in the fact that it does not meet with any albuminous body in the nervous system on which it has a marked effect. Quinia circulates unchanged through the blood, and it is an error to attribute its specific antipyretic properties to its stronger affinity for one or more pyretic poisons, and especially for that form which malaria originates. The power of quinia to arrest malarial fever is due chiefly (*a*) to its antipyretic properties; (*b*) its power to bind the oxygen more firmly with the colored blood corpuscles, and thus to avert the destructive action of the malarial germ or microörganism; (*c*) its poisonous effects upon the microörganisms of malarial fever; (*d*) its tonic effect upon the cerebro-spinal and sympathetic ganglia.

PREVENTION OF MALARIAL FEVER.

No subject is of greater importance to the inhabitants of tropical and temperate regions of the earth, than the destruction or removal of the cause or causes of malaria.

The following propositions should be considered in the discussion of the measures which may be proposed for the destruction or removal of the causes of malaria :—

1. Malaria inflicts a vast amount of disease and suffering upon the human race, and directly and indirectly causes a considerable portion of the mortality in tropical and temperate climates. Notwithstanding the modern civilizations had their rise and development in the most malarial portions of Africa, Asia and Europe, along the banks of the Nile, in its hot, malarious delta, we find the remains of an ancient and grand civilization, which gave birth to that of Greece and Rome, and the great commercial cities of the Phœnicians were located around the malarious borders of the land-locked Mediterranean.

Even medicine had its first birth along the marshy waters of the Nile and in the temples of Isis and Osiris.

The works of Hippocrates (the father of European medicine) were based upon the knowledge which had crossed the Mediterranean from the shores of Africa, and the greater portion of the cases which he details relate to the various forms of malarial fever. Rome conquered the world with the sword and destroyed her citizens by malarial fevers, and through all her various changes, from universal empire to a contracted hierarchy, through all ages, she has retained her deadly malaria. In the malarious regions of Italy and Spain were born and reared Columbus, Cortez, Pizzaro, Ponce de Leon and Ferdinand de Soto. In the malarious regions of the Southern States were bred such men as Washington, Jefferson, Lee and Stonewall Jackson.

The star of empire, which has been steadily passing from the east to the west, has halted in its progress in the great malarious valley of the Mississippi, where it will remain as the centre of political power, physical development and scientific advancement. In those regions in which the earth generates malaria, she also bestows her most bounteous gifts, golden grain, luscious fruits, and every variety of animal and vegetable food. Thus the baneful effects of malaria are counterbalanced to a large extent by the mild and genial climate and the bounteous products of field, forest, river, lake and ocean.

2. The labors of man in clearing the forests, opening and deepening the channels of rivers, draining and tilling the land, have altered the climate and changed the character of the diseases of large portions of the earth's surface.

The malarious belt of the earth has been thus progressively circumscribed by the labors of the agriculturist. In the present century the removal of the causes of malarial fever has been greatly facilitated by the extensive introduction of improved implements and machinery and the use of steam. The drainage of lagoons, swamps and marshes, as well as of the land generally, has removed certain conditions favorable to the development of simply constructed organisms and morbific ferments.

With the increase of the human race, and the advancement of agriculture and the mechanical arts, there will be a progressive diminution of the empire of malaria. The labors of the agriculturist have banished malarious diseases from the greater portions of England, France and Germany. In the early settlements of South Carolina and Georgia the clearing off of the dense virgin forests, even in elevated, hilly regions, was attended with the development of the severest forms of remittent and congestive fevers. At this day the old red clay hills of Carolina are comparatively free from malarial fever.

3. Centuries must elapse before the low grounds, marshes, ponds, lagoons and swamps of the United States of America, and more especially of the great valley of the Mississippi, will be thoroughly drained and under cultivation. The rich returns yielded by sugar-cane, rice and cotton will ever tempt the laborer to disregard the effects of climate, and the gaps in their ranks will ever be speedily filled with new recruits. The question arises, what can be done to protect the laborers in the swamps, rice fields and marshes of the Southern States from the effects of malaria? The author has witnessed, upon thousands of occasions, the destructive effects of malaria upon the human constitution.

If the hardy sons of Ireland, England, Germany and France, and even the dark Latin races of Italy, Spain and Portugal enter the swamps and marshes and rice-fields of our Southern States as laborers, they are almost universally attacked with the various forms of malarial fever during the months of July, August, September, October and November. Many who escape the immediate fatal effects of the acute form suffer with diffuse parenchymatous hepatitis, malarial nephritis, anæmia, anasarca, ascites and prostration of the muscular and nervous forces. Vast numbers of men have perished from the effects of malaria and exposure in building the railroads of the United States. This subject should be thoroughly investigated by the National Government. At the present time vast numbers of men from all parts of the civilized world are suffering and perishing from the deadly effects of the malaria of the Central and South American States, and more especially from the fevers of the Isthmus of Panama. How to protect the laborer from the effects of malaria should call forth the earnest consideration of every civilized nation.

Preceding the American Civil War, in 1859 and 1860, the author undertook an extended investigation of the diseases of the various geological and physical divisions of the Southern (slave States). The investigation of the soil, waters and diseases of the rice plantations, low grounds and swamps of Georgia first engaged his attention. Upon the present occasion we shall present only two results of these labors, namely, those facts which illustrate the poisonous nature of the stagnant water of the swamps and the rules formulated by the author for removing, at least some of the causes for malaria from among the laborers on the rice plantations.

*Poisonous Effects of the Stagnant Waters of the Swamps of Low Malarious Regions. Experiments on Living Animals.**—Water taken from a deep basin in the large canal which drains the rice fields—the swamp was entirely dry with the exception of the deeper portions of the canal—the waters of which had ceased to flow for at least three months, the season having been unusually warm and dry. The fish, terrapins, frogs, alligators and snakes had all collected in these pools of stagnant water, and the living catfish kept their mouths and feelers upon the surface of the water. As the eye rested upon the black and green, turbid waters, scarcely a spot could be discovered not occu-

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* "First Report to the Cotton Planters' Convention of Georgia, on the Agricultural Resources of Georgia," by Joseph Jones, M.D., pp. 269–272. Augusta, Ga., 1860. Analysis 43. Stagnant swamp water, Arcadia swamp, Liberty Co., eight miles from its junction with the North New Port River, June 1st, 1860.

pied by the mouths and feelers of catfish moving tremulously about upon the surface of the water like so many spiders ; in fact, upon a general view, these pools resembled a dark surface of black and green liquid mud, upon which thousands of large spiders were dancing. Every now and then the monotony would be broken by the splash of a mudfish or garfish, or conger eel, or the plunge of a bull-frog. The catfish appeared, in their distress and anxiety to absorb the oxygen from the atmosphere, to disregard alike the presence of man and of the moccasins and water snakes which sluggishly moved in the stagnant pools among their feelers, apparently satiated and disgusted. These stagnant pools, and in fact the whole swamp, under a burning sun emitted a most sickening and disgusting stench. Exposure to this atmosphere, contaminated with the gases arising from the decomposition of vegetable and animal matter, during the heat of the day, from ten o'clock in the morning until three o'clock in the afternoon, obtaining specimens of water and capturing the cold-blooded reptiles, was followed before night by an active diarrhœa. I have before suffered in a similar manner from exposure to these swamps in the summer season. Sulphate of quinia taken upon the appearance of the first symptoms of lassitude and of undue action of the bowels was the means of relieving the unpleasant effects of this exposure in two days ; and I have upon other occasions, when I have been similarly exposed in the prosecution of my inquiries, experienced beneficial effects from sulphate of quinia used as a prophylactic.

The power which quinia possesses of averting an attack of malarial fever is most valuable to the planters of these regions, who are often, during the harvesting of rice, necessarily exposed to the deleterious effluvia of the swamps. That the diarrhœa was caused by the effluvia of these swamps, inhaled during the collection of the waters and samples of the swamp mud and of the natural history specimens, was proved by the fact that my servant man (a strong, healthy negro, who resided on the plantation one mile from this swamp), who assisted in procuring the specimens, was also attacked at night with diarrhœa. I was anxious to test the effects of these waters when absorbed directly into the blood. They were placed in bottles hermetically sealed, and upon my return to Augusta, two days after, I injected several fluid ounces into the subcutaneous tissue of a large Newfoundland dog. The water was injected into the subcutaneous tissue of the back and right fore and hind legs. At the time of the injection the water had the same sickening smell of the swamp. No special symptoms were induced by the injection of the water at the time, but upon the next day there was a slight rise in the temperature of the dog, and the parts upon the back and legs where the swamp water had been injected were greatly swollen. Upon the third day the parts were lanced and discharged much green and yellowish-green, exceedingly offensive matter, together with much most foul and fetid air. The parts continued to discharge large quantities of foul matter and air for ten days. Tar was applied liberally around and within the orifices of the abscesses, to keep away the flies, which I am confident would have destroyed the dog. The dog lost flesh to a considerable degree, but recovered entirely in three weeks. At the end of one month he was killed by the subcutaneous injection of acetate of morphia, and a careful examination with the naked eye and with the microscope was made of all the viscera ; no lesions of the organs were discovered, and no alterations of the viscera were manifest, the color of the liver was natural, and the spleen was not enlarged. The swamp water was not injected directly into the blood-vessel system, for I felt confident that the animalcules and suspended matters which could not be removed by filtration would have produced death by interfering with the capillary circulation in the lungs, independently entirely of any direct poisonous effects. The highly complex nature of these waters will be seen in the following analysis : Specific gravity, 1000.661 ; solid residue in 100,000 grains, 23.400 ; suspended matters in 100,000 grains, 100.000 ; 100,000 grains contain suspended matters, 100 grains ; phosphates of lime and magnesia, 22.224 ; phosphoric acid, 13.958 ; lime and magnesia,

	Normal Blood.	Normal Blood.	Diabetic Blood.	Malarial Blood.	Malarial Blood.	Malarial Blood.
Solid Matters in 1000 parts of Blood	200.000	240.000	161.490	122.447	159 489	166.551
" " " " " " Liquor Sanguinis	100.000	120 000	80.961	74 275	86.978	89.203
Dried Blood Corpuscles in 1000 parts of Blood	120.000	150.000	92 702	51.987	79 437	85.968
Moist " " " " " " "	480.000	600 000	370.808	207.948	317.748	343 872
Liquor Sanguinis " " " " "	400.000	520.000	629.192	792.052	682.252	656.128
Fibrin in 1000 parts of Blood	2.000	3.500	2.806	1.925	0.877	1.450
Fixed Saline Constituents in 1000 parts of Moist Blood Corpuscles	8.120	10.500	11.981	0.841	10.728	1.648
Fixed Saline Constituents in 1000 parts of Dried Blood Corpuscles	65.000	70.000	49.916	3.240	42.914	6.595
Fixed Saline Constituents in 1000 parts of Dried Blood	70.000	80.000	56.108	27.083	36.341	37.909
Fixed Saline Constituents in 1000 parts of Solid Matters of Liquor Sanguinis	88.053	95.000	68.488	44.779	30.205	75.558
Fixed Saline Constituents in 1000 parts of Liquor Sanguinis	8.550	10.100	5.320	3.326	2.647	6.630

We have now all the necessary facts for the intelligent treatment of this case. The indications in the treatment of this case of diabetes mellitus are:—

1. To strengthen digestion. His stomach fails to digest the nitrogenized elements, the substances which he needs to supply the rapid waste of his tissues.

2. To afford the organic and inorganic materials of structure.

3. To quiet and strengthen the nervous system.

4. To arrest the destruction and transformation of the elements of the blood, tissues and food into animal starch and grape sugar.

The article on diabetes mellitus was followed by nine articles published in nine consecutive numbers of the *Southern Medical and Surgical Journal*, extending from June, 1858, to February, 1859, inclusive, giving 53 cases of malarial fever in detail, illustrated by the details of 16 autopsies, 66 analyses of the urine, and nine elaborate analyses of the blood, the whole constituting a closely printed octavo of 235 pages.*

At the meeting of the American Medical Association in Louisville, Kentucky, in 1859, the author presented an extended memoir, based upon his physical, chemical, microscopical and pathological investigations of the various forms of malarial fever, embraced in six chapters, and covering, in a closely printed volume of 419 pages, the results of the critical study of several hundred cases of malarial fever (intermittent, remittent, congestive and pernicious), illustrated by elaborate tables of the changes of the temperature, pulse and respiration, and of the blood, urine and organs in the various stages of the disease.† In this work the author endeavored to delineate correctly the natural history, chemistry and pathology of the various forms of malarial fever, and to base upon these results a rational and scientific method of treatment.

Preceding this publication medical literature possessed only a few detached observations relating to intermittent fever, but possessed no systematic investigations detailing the changes of the pulse, respiration, temperature, blood, urine and organs, in the various forms of malarial fever.

With reference to the blood, it was clearly established by these investigations, which preceded the American Civil War—

1. That the malarial poison rapidly destroys the colored blood corpuscles in all the various forms of intermittent, remittent and congestive fever.

* "Observations on Malarial Fever," by Joseph Jones, A.M., M.D. *Southern Med. and Surg. Jour.*, June, July, August, September, October, November, December, 1858; January and February, 1859; New Series, Volumes XIV and XV, Augusta, Georgia.

† "Observations on some of the Physical, Chemical, Physiological and Pathological Phenomena of Malarial Fever," by Joseph Jones, A.M., M.D. The *Transactions* of the American Medical Association, Vol. XII, Philadelphia, 1859, pages 209-627.

2. The destruction of the colored blood corpuscles may take place rapidly during the active stages of the disease or more slowly during the chronic stages of the disease.

3. The destruction of the colored blood corpuscles was demonstrated both by chemical and microscopical analyses, and the peculiar appearance presented by the pigments, granules and colorless corpuscles pointed out.

4. The fibrin is decreased in the various forms of malarial fever, and the changes in the physical and chemical characters of this element were applied to the explanation of certain phenomena witnessed more especially in the hemorrhagic fevers.

5. The changes in the color of the liver and spleen in malarial fever are shown to be characteristic of this disease, and to be due chiefly to the action of its poison upon the colored blood corpuscles.

6. The microscopical and chemical differences between the changes of the blood and organs in malarial and yellow fevers were carefully defined.

7. Principles of treatment, based upon the results of chemical and microscopical analyses and investigations with the thermometer, and upon pathological research.

In 1859 and 1860, the author undertook an extended investigation of the diseases of the various geological and physical divisions of the Southern (slave States). The investigations of the soil, waters and diseases of the rice plantations, low grounds and swamps of Georgia first engaged his attention. One of the most important objects of this investigation was the determination, by chemical analyses and microscopical investigations, and by experiments upon living animals, of the natural cause of the various forms of malarial fever.

The accomplishment of this end necessitated extensive travel among the swamps and rice fields, and careful chemical and microscopical examination of the waters, and the following facts were determined, which have a direct bearing upon the subject now under investigation:—

1. The complex chemical nature of the soil and waters, and especially of the organic matters.

2. The vast variety of vegetable and animal microörganisms found in the waters of the swamps, rice fields, creeks, marshes and rivers of the malarial regions of the Southern States.

3. The poisonous nature of the exhalations from the stagnant waters of swamps and rice fields and their power to induce dysentery and malarial fever in human beings.

4. The poisonous nature of the waters of swamps and rice fields and their power to induce the various forms of malarial fever when drunk by human beings.

5. The poisonous nature of the stagnant waters of swamps and rice fields when injected subcutaneously into living animals.

As far as our researches extend these were the first experiments ever devised in the history of medicine for the direct solution of the problem of the poisonous properties of the stagnant waters of swamps, marshes and rice fields by introduction into the blood of animals.

As these researches contained much matter of value to the agriculturist, and as they contained not merely numerous analyses of the soil, minerals and waters of Georgia and South Carolina, and the results of an extended search for the beds of phosphates which have in late years proved of so great value to the agriculturists of America and Europe, but also elaborate hygienic and sanitary rules for the guidance of the laborers in the rice, sugar and cotton plantations, many of the results were embodied in a paper or volume of 319 pages to the Cotton Planters' Convention.*

During the American Civil War, 1861–1865, the author conducted an extended series of investigations upon the diseases of the troops in the field and in the military

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* "First Reports to the Cotton Planters' Convention of Georgia on the Agricultural Resources

hospitals in Virginia, North Carolina, South Carolina, Georgia and Tennessee, and among the Federal prisoners confined in Richmond, Va., and Andersonville (Camp Sumter), Georgia, and a large number of the cases of typhoid and malarial fever passed under his observation in the field and general hospitals, and in the beleaguered towns and cities. The great military hospitals of the Confederate armies located in Gordonsville, Charlottesville, Virginia, Charleston, South Carolina, Savannah, Augusta, Atlanta, Marietta, Macon, Vineville and Andersonville, Georgia, afforded the grandest field ever offered to a Southern physician and surgeon for the investigation of the various forms of endemic, epidemic and contagious fevers, and of the gunshot wounds, casualties and diseases incident to the campaigns and battles of great armies.

A careful consideration of the causes which the author has recorded in his "Medical and Surgical Memoirs," Volume II, pp. 152–161, with reference to the microörganisms of the intestinal canal, and of the mesenteric and Peyer's glands and urine in typhoid fever, and the comparison of these with the subsequent observations of Klebs and others, justify the claim of the author as one of the discoverers of the microörganisms of typhoid fever.

During the civil war, 1861–1865, he had no means of presenting his labors to the scientific world.

These investigations, with accurate details of cases, with elaborate drawings, were continuously forwarded to the Surgeon-General's office in Richmond, Virginia, in 1862, 1863 and 1864, and constituted three large manuscript volumes.

These labors were destroyed by fire at the time of the burning of the Confederate capital.

The author retained the first and original draft of the cases and drawings, and from them he has reproduced the details and illustrations recorded in the second volume of his "Medical and Surgical Memoirs."

We will content ourselves with the mere record in a foot-note of some of the publications relating to malarial fever and kindred diseases.*

After a continuous term of service in the Charity Hospital of New Orleans, from October, 1868, to April, 1870, during which period the author was continuously and

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of Georgia," by Joseph Jones, M.D., Augusta, Georgia, 1880; see also "Medical and Surgical Memoirs," containing Observations on the Geographical Distribution, Causes, Nature, Relations and Treatment of Various Diseases, 1855–1856, by Joseph Jones, M.D., Volume II, New Orleans, 1887, pp. 1111-1116.

* "Sulphate of quinine administered in small doses during health is the best means of preventing chills and fever and bilious fever and contagious fever in those exposed to the unhealthy climate of the rich lowlands and swamps of the Southern Confederacy," by Joseph Jones, M.D. *Southern Medical and Surgical Journal*, Volume XVII, No. 8, Augusta, Georgia, August, 1861, p. 593-614. "Indigenous remedies of the Southern Confederacy which may be employed in the treatment of malarial fever," by Joseph Jones, M.D. Number 1, *Southern Medical and Surgical Journal*, Volume XVII; Number 9, Augusta, Georgia, 1861, pp. 673-718. Number 2, *Southern Medical and Surgical Journal*, Volume XVII, No. 10, October, 1861, Augusta Georgia, pages 754-787. "Relations of Pneumonia and Malarial Fever, with practical observations on the Antiperiodic or Abortive method of treating pneumonia," by Joseph Jones, M.D. *Southern Medical and Surgical Journal*, September, 1866, page 229. "On the prevalence of pneumonia and of typhoid fever in the Confederate army during the war of 1861-1865," by Joseph Jones, M.D. "Sanitary Memoirs of the War of the Rebellion," collected and published by the United States Sanitary Commission, New York, 1867, page 335. "Investigations of the Diseases of the Federal prisoners confined in Camp Sumter, Andersonville, Georgia," by Joseph Jones, M.D. "Sanitary Memoirs of the War of the Rebellion," collected by the United States Sanitary Commission, New York, pages 467-655. "Trial of Henry Werz," 2d Session, 40th Congress, 1867-1868. Executive Document, No. 23, Medical Testimony, Dr. Joseph Jones. "Reports embracing description

exclusively engaged in clinical studies in the wards, in chemical and microscopical analyses in the laboratory, and in post-mortem examinations and pathological researches in the dead-house, the cases treated, with all the chemical, microscopical, pathological and therapeutical data, and anatomical and microscopical specimens, were classified and published, for the use of the medical profession and the students of the medical departments of the University of Louisiana, in two groups.

The first group related chiefly to diseases of the nervous system.*

The second group embraced the microscopical and chemical changes of the blood in malarial fever, diseases of the circulatory and respiratory system, and of the spleen, kidneys and liver.

A large portion of the second division was devoted to the consideration of dropsy as a symptom of various diseases, and this most important subject was discussed under the following heads:—

1. *Dropsy arising from derangement in the nutrition of the tissues, leading either to an increase of secretion or a diminution of absorption.*

2. *Dropsy arising from derangements of the blood, leading to derangements of the nutrition of the tissues, with an increase of secretion or a diminution of absorption.*

3. *Dropsy arising from derangements of the circulatory apparatus, attended with venous obstruction and congestion, increased serous effusion from the distended blood vessels and diminished absorption, cardiac dropsy, hepatic dropsy.*

4. *Dropsy arising from derangements or lesions of the organs which regulate the amount of the blood, as well as its constitution, by regulating the amounts of the watery elements, and by the elimination of excrementitious materials. Renal dropsy.*

Each division was illustrated by cases, post-mortem examinations and microscopical and chemical investigations, and the changes induced by the action were noted throughout the entire investigation; but it was chiefly under the second division of dropsy that the malarial poison was recognized as a principal factor, in the profound changes it produced in the composition of the blood.

Thus we held that the prolonged action of the malarial poison not infrequently induces such changes in the composition of the blood, and such derangements in the liver and spleen, as to lead to the effusion of serous fluid into the areolar tissue and peritoneum-abdominal cavity. The changes of the blood induced by malarial fever appear to be the chief cause of the dropsical effusions, although in some cases this symptom may be attributed to the mechanical obstacle afforded by the enlarged spleen and liver.

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of the Stockade, and condition of the prisoners therein confined, and condition of the hospitals, etc," page 618, page 641, manuscript, pages 1721 and 1766. "Investigations upon the nature, causes and treatment of Hospital Gangrene as it prevailed in the Confederate armies, 1861-1865," by Joseph Jones, M.D. "Surgical Memoirs of the War of the Rebellion," collected and published by the United States Commission, New York, 1867, pages 142-580. The Charity Hospital of New Orleans has, from the removal to this city, in the winter of 1868, up to the present moment, furnished an extensive field for investigation in therapeutics and pathology upon all subjects relating to the etiology, pathology and treatment of fevers. During a period extending from 1869-1886 inclusive, the cases of various diseases treated by the author in the wards of the Charity Hospital numbered 6311, with 668 deaths; the various forms of malarial fever numbered 2885 cases, with 88 deaths. During this period a large number of cases of malarial fever were also treated in private practice.

* Memoranda of Medical Clinic at Charity Hospital, New Orleans, Louisiana, 1869-1870. By Joseph Jones, M. D. Section I. Diseases of the Nervous System. *The New Orleans Journal of Medicine*, April, 1870, pages 233–273. Section II. Dropsy Considered as a Symptom. *New Orleans Journal of Medicine*, July, 1870, pages 484–563. "Medical and Surgical Memoirs," by Joseph Jones, M. D., New Orleans, Louisiana, 1876.

wine in one instance, and to its bad quality in the other, for it is well known that, like other high-priced remedies, it does not escape adulteration when it falls into the hands of dishonest traders.*

A comparison of these facts with the great sickness and mortality of the white explorers and residents and sailors of the African coast and rivers, demonstrates conclusively :—

1. Quinine taken during exposure to the exhalations of miasmatic regions will, in most cases, ward off fever entirely.

2. If fever attacks those to whom the quinine has been regularly administered, its severity and duration will be far less than in those who have not taken the quinine; it therefore not merely wards off disease, but renders it less powerful and destructive when present.

3. To be entirely efficient the quinine must be administered for some time, at least ten days, after exposure to the causes of fever. *Southern Medical and Surgical Journal*, Augusta, Georgia, August, 1861, Vol. XVII, No. 8, pp. 593–614.

The observations which I have been able to make during the late war have confirmed the accuracy of the preceding statement; and I am convinced that the health and efficiency of the troops in certain malarious localities of the Confederacy would have been greatly promoted by the daily use of quinine in the manner recommended. The value of quinine as a prophylactic in preserving the efficiency of troops serving in damp, unhealthy, malarious regions may be readily demonstrated by a direct calculation. The following table illustrating the numerical relations of malarial fever to the other diseases, and its effect in reducing the strength of the command serving at Fort Jackson and the surrounding river batteries, situated in the low rice lands of the Savannah river, will furnish sufficient data for the calculation:—

TABLE.

CASES OF MALARIAL FEVER AND ALL DISEASES OCCURING DURING A PERIOD OF FIFTEEN MONTHS, OCTOBER, 1862, TO JANUARY, 1864, IN THE COMMAND SERVING IN AND AROUND FORT JACKSON, ON THE SAVANNAH RIVER.

Month and Year.	Congestive Fever.	Intermittent Fever, Quotidian.	Intermittent Fever, Tertian.	Intermittent Fever Quartan.	Remittent.	Total Cases of those Forms of Malarial Fever.	Total Cases for all other Diseases.	Total Cases of all other Diseases.	Aggregate sick each month.	Mean Strength of Command, Officers and Men.
October, 1862	...	262	71	...	12	345	126	471	583	872
November, 1862	...	67	24	...	5	96	44	140	218	913
December, 1862	...	128	58	...	11	197	118	315	350	913
January, 1863	...	42	88	...	5	135	172	307	331	1144
February, 1863	...	85	104	...	9	198	149	347	428	913
March, 1863	...	78	133	33	2	246	143	389	458	913
April, 1863	...	37	157	...	4	198	226	424	489	913
May, 1863	...	62	76	...	2	140	184	324	360	878
June, 1863	...	66	66	...	10	142	131	273	316	878
July, 1863	...	77	177	...	67	321	137	458	504	878
August, 1863	...	99	149	...	134	380	103	483	533	890
September, 1863	...	149	127	...	134	410	98	508	588	822
October, 1863	...	97	108	...	62	267	133	400	485	660
November, 1863	1	47	54	...	22	124	60	184	235	789
December, 1863	1	41	62	...	10	114	111	225	279	800
Total	2	1337	1454	33	489	3313	1935	5248		

* "Statistical Report of the Health of the Royal Navy, for the year 1857," ordered by the House of Commons to be printed, August 2d, 1859, pp. 78–85.

In an average command of 878 men, stationed at Fort Jackson and the surrounding river batteries, nearly one-half, or 410, on an average, were on the sick list each month; and the new cases of malarial fever averaged each month 220. During this period of fifteen months 3313 cases of malarial fever, in the form of congestive fevers, quotidians, tertians, quartans and remittents, occurred, while all other diseases, including also those diseases, as neuralgia, which might be traced in a measure to the action of malaria, numbered 1935 cases, or only a little more than one-half the number of the cases of malarial fever.

Throughout the entire period more than one-fourth of the command were unfit for duty; and during the fall months more than one-half of the garrison was, on an average, incapable of performing military duty. In case of an attack during the sickliest season of the year the effective force of the command, instead of being 878, would be less than 500. In using quinine as a prophylactic in such a command it would be necessary to administer the drug at least five months, namely, June, July, August, September and October. If three grains of quinine in a gill of whisky be administered daily to each soldier we may safely estimate the amount of quinine necessary to protect each man during these five months at about one ounce. This command of 878 men would, therefore, require for its protection annually about 878 ounces of sulphate of quinia.

During a period of twelve months, from October, 1862, to November, 1863, 2808 cases of malarial fever were treated, and if we allow fifty grains of quinine as necessary on an average to the treatment of each case, very nearly 300 ounces of quinine would be consumed in the treatment of these cases. It is important also to bear in mind that this amount of quinine would in many cases produce only temporary relief, after the disease was once established, and would be powerless when thus occasionally used to prevent the serious lesions of the spleen and liver, and the disease would be liable to return again upon the slightest exposure to the original cause, or to cold and damp, even in healthy regions. It should be further considered that the process of acclimation in the white race is slow, if not altogether impossible in our Southern swamps and rice fields, and that an entire command might be gradually rendered unfit for service by the effects of malaria in such a locality as Fort Jackson; and even after the men are removed to healthy regions they are liable for many months, and even for years, to a recurrence of the various forms of malarial fever.

Amount of quinine necessary to protect 878 men from malarious diseases, during twelve months, 887 ounces at an average cost of $5.00 per ounce.....	$4390 00
Amount of quinine necessary to treat 2808 cases occurring among a command of 878 men, during twelve months, at an average cost of $5.00 per ounce.....	1500 00
Difference of cost of quinine in protecting and treating these cases.....	$2890 00

According to this calculation the quinine necessary to protect the soldier from malarial fever would cost $2890 more than that assumed to be necessary to treat the cases of fever arising where no quinine had been used as a prophylactic. We must, however, introduce into this calculation the pay of the sick, officers and men, which may justly be considered as an unproductive expenditure. If we place the number of men constantly on the sick list and unfit for duty from malarial fever at 100, which is far below the actual number, and if we rate them as privates alone, each month $1100 would be expended in the payment of sick men, or $13,200 would be annually expended without any return whatever to the Confederacy. If we add to this the pay of sick officers the sum would reach a much higher figure; but we simply desire to demonstrate the utility of the use of quinine as a prophylactic, beyond all cavil, even as a mere matter of dollars and cents.

Unproductive pay of 100 men for twelve months, laboring under the various forms of malarial fever ($10 per month for each man)	$13,200
Increased cost of quinine for the protection of the entire command during twelve months	2,890
Difference in favor of the use of quinine as a prophylactic	$10,310

It should also be taken into the account that the expenses in food, nursing, hospital accommodations, other necessary medicines and transportation for the sick, are greater than the expenses of the supplies of the well soldiers; and it would be just, even to consider that the expenditures for the sick are a total loss, for they certainly add nothing to the defence of the country or the efficiency of the army. But, leaving this entirely out of the calculation, we have demonstrated clearly that the use of quinine as a prophylactic would be attended with an actual saving of expense, for in exposed malarious localities a less number of troops, properly protected, could be made to perform more efficiently the duties of a much larger force. Surely the accomplishment of such a result is of value in a contest in which we are opposed to a powerful enemy, who outnumbers us in the ratio of three to one, and who, with almost exhaustless resources, has his ports open to the commerce of the world. The argument which might be urged on the score of humanity is even stronger than that based upon efficiency and economy. We must believe that the preservation of our soldiers from acute diseases, as well as from chronic affections, with enlarged spleens, impoverished and watery blood, dropsies and innumerable nervous derangements, excites some interest and concern in the minds of their officers, as well as their relatives and friends at home. The difficulties of importing quinine at the present time are without doubt numerous, but they are not greater, and are perhaps far less, than the difficulties of the importation of the more bulky articles of clothing and luxury, which has been carried on to such an extent as to drain the country of gold, and to seriously endanger the moral and financial condition of the Confederacy. With the large amount of cotton at the command of the people and the government, it would not be an impossibility to import a sufficient quantity of quinine to protect the troops exposed to malaria. Owing to the limited supply, quinine was not used to any extent as a prophylactic in the Confederate Army, and in several instances where the attempt has been made to use it thus, it has failed to yield the most satisfactory results, from its irregular and unsystematic employment. It appears that it is very difficult to induce soldiers to take quinine in the state of powder. The proper mode would be to mix the quinine with whisky (a certain number of ounces to a barrel of whisky), and issue the medicated whisky at a certain hour each day, in the presence of officers charged with the duty of seeing that each man took his dose. As a general rule, soldiers will not refuse whisky, even when it contains quinine. Several instances have come under my observation where medical officers serving in malarious localities have taken quinine daily as a prophylactic, and while almost the entire command have suffered with the various forms of malarial fever, they have escaped with impunity. In the summer and fall of 1863, during the great changes from the Military Department of Georgia and South Carolina to Piedmont, Virginia, and from thence back to Carolina and Georgia, and during considerable exposure to malarious influence in localities like James Island, acknowledged to be sickly, I protected myself with quinine. Doctor J. N. Warren, Assistant Surgeon of the Twenty-fifth Regiment, South Carolina Volunteers, stationed on James Island, S. C., in compliance with a request which I made him during a visit to the camps on James Island in the month of April, 1863, selected two hundred men from the regiment and administered four and a half grains to each man daily. This was continued regularly until the 1st of October, when Dr. Warren was transferred to Augusta. During this period, among this body of men only four cases of malarial fever and one case of typhoid fever occurred. The remainder of the regiment, between three hundred and four hundred men, did not take

quinine as a prophylactic, and the majority of these men were attacked by paroxysmal fever; and over three hundred cases of the various forms of paroxysmal fever, together with twenty-three cases of typhoid fever, occurred among them. During the service of this regiment at Battery Wagner, the men who took quinine daily bore the fatigue better and resisted the deleterious effects of the climate and the foul air of the bomb-proofs better than those who did not thus use quinine.

I received from Surgeon Octavius White, C. S. A., in 1862, a report in favor of quinine as a prophylactic against malarial fever, and also from Surgeon Samuel Logan, Department of South Carolina and Georgia, C. S. A., contributing important facts illustrating the prophylactic powers of quinine, and from Dr. D. Du Pre, of Nashville, Tenn., in 1867, in which he recorded instances of the prophylactic powers of quinine. *

In the use of quinine as a prophylactic against malarial fever, the following questions are worthy of consideration :—

1. To what extent can quinine be used daily as a prophylactic against malaria without inducing any injurious effects on the nervous system?

2. How long can quinine be used daily as a prophylactic against the effects of malarial fever without losing its power or without inducing injurious effects upon the human system?

3. What proportion of the entire population in malarious regions could be preserved from malarial fever by the use of quinine as a prophylactic?

4. What effect upon the total mortality, as well as upon the number and character of various diseases, would the prophylactic use of quinine induce during given periods of time in malarious regions?

5. To what extent can arsenic (arsenious acid) and the compounds of arsenicum be substituted for quinine for the prevention of malarial fever?

6. What effect upon the human organism and upon the character and number and mortality of various diseases will arsenic produce when used as a prophylactic?

The preceding questions are of great importance, and their investigation should demand the attention of the medical profession in all malarious regions. Scientific commissions of experienced and accomplished medical men should be appointed by the leading powers of the civilized world for the thorough investigation of the origin, nature, propagation and prevention of the morbific ferment of malarial fever. To be properly constituted, each commission appointed by the individual nations, as Great Britain, Germany, Spain, Italy, Austria, Portugal, Turkey, Russia, France and the United States should be constituted thus: Chemist, microscopist (bacteriologist), botanist, physiologist (experimental), hygienist, therapeutist, physician (practicing, of enlarged experience as to malarious diseases). The first duty of the State is to protect the lives of the laboring classes from all causes of preventable diseases. To what extent the cause of malaria may be removed and its effects modified or avoided, can only be determined by the careful investigations of competent, honest, conscientious, scientific men, liberally supplied with all the instruments, reagents and processes of the Nineteenth century. Whatever the results of such labors might be, they will illustrate the humanity as well as the science of the civilization of the present day.