THE CONTROL OF YELLOW FEVER

ITS POLITICAL SIGNIFICANCE

AND THE SPECIAL

RESPONSIBILITY OF THE BRITISH

EMPIRE.

Thesis submitted for the

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by

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1. INTRODUCTION.

The present thesis is based on work which has extended over a long period of years.

As far back as 1917 I had already gathered considerable material on the subject when the completed compilation was lost in H.M.S. "Hilary" in that year. She was sunk by enemy action.

It is perhaps fortunate that my previous immature work could not be presented. Since then an experience of twenty-five years of world travel covering perhaps the most vivid twenty-five years of history has enabled me to extend my work and the present thesis is submitted with the humble but sincere hope that it may add to the appeal for sanity in the deliberations of those who are striving to restore world peace.

A lack of imagination is at once one of the strengths and weaknesses of the British peoples. Disaster has often to be upon them before they can be aroused to take measures for defence, when by vision and forethought it could have been averted.

Only by such vision and action now, can the disaster be avoided which would follow the

dis-organization of Sanitary Cordons inevitable in a World War.

I had an opportunity of seeing this on a small scale during one of the revolutions in Brazil when non-immune troops were sent to the endemic areas of the North, in 1926.

Yellow Fever broke out among those troops, and panic ensued, although Brazil has been accustomed to that disease for hundreds of years.

During 1925, when I was Director of the Yellow Fever Campaign in Parahyba do Notre in Brazil, Small-pox devastated the city, but that was taken calmly, as it was a regular occurrence, but, when a few cases of Yellow Fever were introduced from the <u>outside</u> into a city free of the vector, Aedes agypti, and therefore safe from spread, the panic was spectacular.

That was because everyone knew that the Authorities had, in vaccination, the means to check and prevent Small-pox, and that it was due to contact with humans, and willingly submitted to those

means. Yellow Fever, on the other hand, was a "MYSTERY" to superstitious people - and most people are - and considered as a Visitation.

The difference between the comparatively sparsely populated and immune Brazilian endemic area and the congested and absolutely non-immune tropical East, where the Aedes agypti is the common domestic mosquito and proved vector, is only one of degree, but of alarming magnitude.

Again, while the control of Aedes agypti is simple, and the method thoroughly understood and worked out over years, with complete success in the West, the East has much more complicated problems.

The ease of Aedes agypti control is due to its entirely domestic breeding habits, and control of the habits of the people as regards their water supply also controls the mosquito, but in the East there are other mosquitoes not domestic in their breeding habits but feeding avidly on humans, such as Aedes Albopictus, which can convey Yellow Fever. These mosquitoes breed in the jungle and plantation.

It is admitted that, as in the case of

Malarial control, finance is paramount; this is the case also in Yellow Fever. The financial requirements of Yellow Fever control in an entirely Aedes agypti area, as in Brazil, being concomitant with the modern requirements of a pure water supply the expense is, in terms of control, within the sanitary budget.

On the other hand, the expense of controlling mosquitoes which breed outside houses on waste land as well as cultivated land would be prohibitive.

It is essential, therefore, that Yellow Fever never reaches the East.

Carter, in his masterly work "The Early History of Yellow Fever" (1931), has shown how the disease came with the slave trade from the West Coast of Africa to the East Coast and Islands of the Central and South Americas. The wooden sailing ship of those days was ideal for the mosquito vector, and this manner of spread only ceased with the change to metal ships.

During the days of slow sail the mosquito was the factor that mattered because, once infected,

it could remain alive long enough to infect humans on arrival at the other side, without the necessity of transference through man. This will be explained in detail in another section. Now we have both fast water, and still faster air transport. I well remember my thoughts when, at Pernambuco in February 1926, I saw Major Franco, the Spanish Aviator, land from Dakar in the first flight across the Southern Atlantic. Before, the insect alone could come, or, as was more usual, man and insect came together, for man alone would have been dead or recovered in the time necessary to make the crossing; now, as a result of air travel, either or both could come alone or together.

Four years later, although only eight trans-South Atlantic flights had been made, my forebodings were unhappily proved right, by the discovery of A.gambiae in the town of Natal after a severe outbreak of Malaria. This mosquito, the common vector in Africa, had never before been in America and the town of Natal had never before had an epidemic of Malaria.

Malaria had been present only in the outskirts

and further country, never in the town itself, due to the unsuitability of the breeding places for the native mosquito but A.gambiae found in the town ideal and preferential breeding pools.

If the Anopheline mosquito, a much less hardy insect than the Aedes agypti, could survive a crossing, what was to prevent the spread of Yellow Fever to the East by the same means?

As will be shown, this has, up until now, been prevented by rigid sanitary control both of ships and aeroplanes under international arrangement. What hope have we that this agreement would be continued under the disruptive factors in war? We know from past experience that it would not.

What then can be done? The British Empire, at least, can do a great deal which at present it is not doing, and the burden of this Thesis is how and what to do. During the three years in which I helped to control Yellow Fever (1923-1926) in Brazil my ideal was to take all Entomological phenomena seen in the laboratory to the field and conversely to attempt to elucidate all field phenomena in the Laboratory.

Many experiments were made and many reports sent to the International Health Board of the Rockefeller Foundation, under whose auspices I was working. Not only was the Entomology of Aedes agypti studied, but also the Epidemiology of the disease in relation to the history and economy of the country.

The International importance of the question naturally came to be realized, but the opportunity to see for myself meant years of waiting and many thousands of miles of travel.

Since that time - 1926 - I have made 5 complete voyages round the world, touched at all of the large centres of tropical population and many of the smaller, taken the Diploma of the London School of Tropical Medicine, studied the political and financial situation bearing on the subject, and finally remained long enough in the East (Malaya) to find out by experiment the relation of my Brazilian findings, as regards the Aedes agypti, to the conditions there.

From this, I am of the opinion that there is only one means of controlling Yellow Fever or preventing it gaining a foothold, and that is by

the time-honoured and proved method of dealing with the vector in its larval state.

One admits that great advances have been made in the immunology and serology of the disease and that protection can be given to a proportion of those exposed, but in view of the immense populations which would have to be dealt with in the East, it would be a mere gesture. There would seem to have been a tendency to develop the purely scientific laboratory side of the study of Yellow Fever to the neglect of control and field work, which is an art.

The great and original demonstrations of this art, in Havana and Panama, followed a very scanty knowledge of the Entomology and Epidemiology of the disease, but were entirely and finally successful, and when Noguchi was making his tragic proto-zoological errors, the disease was being conquered in the very countries where he was making them.

The main object of all scientific work is to understand, to predict, and lastly to control, but the greatest of these is to CONTROL.

HISTORICAL SURVEY, EPIDEMIOLOGY AND GEOGRAPHICAL DISTRIBUTION.

To appreciate the present danger of Yellow Fever, a careful study of its past history must be made, especially that part when it first manifested itself to the civilized world.

This study has natural divisions, the first of which is its origin.

Origin.

The evidence to be examined is both Biological and Historical, and, of the latter, negative and positive.

Yellow Fever has been permanently endemic in only two regions, the tropics of West Africa and the Americas. In other regions it has either not appeared or, having appeared, not established itself.

In the ancient world of the Mediterranean, about which we have a long general and medical history, there is nothing to show its existence until well after regular communication had been begun with the regions which we propose to examine.

Biological Evidence.

Carter, in "The Early History of Yellow Fever". states:- "The reaction of the negro to Yellow Fever is, I think, just what one would expect to be evolved in a race, for many generations, subject to that infection. Negroes contract the disease, so far as we know, as readily as other races, but have it more mildly and rarely die of it. Thus they are apparently as susceptible to the infection as other races, but less susceptible to the toxins; and this is what we would expect in the evolution of a race long subject to Yellow Fever. The American Indian, on the contrary. has shown no immunity either to the infection or the toxin. He contracts Yellow Fever and dies of it as readily as the white man".

The proved vector, Aedes aegypti, is found in many ports the world over, and also far into the Interior, but this does not mean that it originated at any one of those places, as it is easily carried in ships, especially wooden ships, so that it would be ultimately distributed, climate being favourable, from what ever place it originally existed in permanence.

The insect is biologically differentiated as a commensal of homo sapiens, and not one of the older forms, so that one should find in the original region other forms allied to it, but not so biologically differentiated.

No other species of the sub-genus is found in the Americas, but there are many species in West Africa and elsewhere in the Old World. These other species breed with Aedes agypti and have a similar biology and we may therefore deduce that it is, originally, an Old World insect. Before 1492, the date of the discovery of America by the Old World, the insect could not have been introduced by immigration from North China by way of the Aleutian Islands, owing to the cold climate through which it would have had to travel; therefore, if this insect established itself in the Americas only after 1492, Yellow Fever could not have existed there before that date.

The weight of biological evidence both from the point of view of the vector and the host gives the Old World origin an antecedent probability of great significance.

Historical Evidence.

Notwithstanding the biological evidence pointing to West Africa, we must admit that the first recognition of the disease as an entity was made in the New World.

Both West Africa and Tropical America came into intimate communication with Europeans at about the same time, and a long time before Yellow Fever was recognized in either region. . Cape Verde was rounded in 1444 and the first settlement, Sao Jorge da Mina, was made on the Guinea Coast in 1482, eleven years before Columbus founded Isabella in the newly discovered Americas. Early and intimate communication was established between these two regions enabling both the disease and its insect vector to have been transferred from either one to the other and become established in which ever was its new home before it was definitely recognized in either.

The bond of union between these regions was the slave trade which began almost immediately on the discovery of America and Herrera (v.1 dec, 1 lib5)

states that the Governor of Hispaniola petitioned that "no more negroes be allowed to come in as they were already too many for good order", this being in 1503. This trade began with the Spanish and Portuguese but was continued by the English and French later. The disease was carried back and forth many times and consequently each accused the other of being the source of infection.

The "Fever of Bulam" was brought from West Africa in 1793 to the Island of Grenada, and spread widely over the Lesser Antilles and South Carribean region, while in 1866, a ship, the Rosa del Turia, with 200 deportees from Havana carried the infection to Fernando Po where it spread to other islands in the Gulf of Guinea making great ravages. (Yglesias y Pardo, quoted by H. Rey 1878).
Many other instances are on record, and Flu (1910) states that "Yellow Fever which was epidemic in Togoland was imported from America probably before 1896".

It can thus be understood that much confusion has justifiably arisen among the earlier epidemiologists. We know that, in order that the disease

can be endemic certain conditions must be present in terms of heat, moisture and concentration of population.

Before the discovery of America by Columbus there were only four regions which fulfilled these conditions to wit- the Gulf Coast of Mexico, the Maya country of Yucatan and Central America, the Coastal Region of Peru and the area around the Carribean, both mainland and islands, linked by voyages of the natives, to make a unit. These regions would serve as permanent endemic foci from which the disease could spread causing epidemics at a distance.

We can eliminate the Peruvian region because it was isolated from other concentrations of population living in conditions favourable to continuous Aedes aegypti activity.

The history of this region is well known and no epidemic is recorded either among the natives or Spaniards until long after the Conquest, when Small-pox and Typhus were brought in and caused havoc amongst the former. As to the Carribean region it is not so easy to be definite, but we do know that after discovery and settlement by Europeans when susceptible immigration, population, and inter-

communication was greater than in the pre-Columbian period, Yellow Fever died out more than once and did not establish itself continuously which proves that it could not have been, by itself, a permanent focus, although by communication with other permanent foci, it might have maintained long continued epidemics and re-infected other regions. The curtailment of trade and communication during the last war is a case in point (Carr, Times of India, Jan, 13th, 1926).

The other two regions had all that was necessary to form permanent endemic foci. Heat and moisture for the insect, and a concentration of population sufficient to furnish enough susceptible persons to continue the disease indefinitely. These regions are close enough to provide easy communication and, were the disease originally present in either, it would spread to the other, at first epidemically, then endemically, according to the social condition existing at the time.

Examination of Pre-Conquest Records.

In August 1521 Cortes captured Mexico City. He found that records were kept in picture writing

and hieroglyphics. These were translated into Spanish and also French. The conquest itself did not upset the social conditions of the Mexican people. The petty states continued to be ruled under the Spaniards as before, and the codices continued to be kept throughout, and after the conquest, as before. For seventy-five years before the conquest and for about sixty years after, we have good and reliable records of wars, territorial expansion, deaths and accession of rulers, record of eclipses, storms, earth quakes, droughts, famines and unusual mortality from divers causes. Less reliable but good accounts, and what is important, unbroken, are found in The Anales de Cuauhtitlan from 635 to 1519. The chronology is absolute as it can be verified against the dates given for eclipses of the sun. These records are important because they include data concerning troop movements from the "Tierra fria" to the "Tierra caliente", in other words the "acid test of the presence of Yellow Fever in an endemic area" (Carr, unpublished report to the International Health Board, July 1926).

In 1926, during the Yellow Fever campaign in Bahia, Brazil, the presence of non-immune troops

from the cold South soon uncovered Yellow Fever, which had been smouldering unrecognized in the Interior towns of that state. One would therefore expect to find in the records mention of what would have been an "unusual mortality" had such occurred.

Carter, The Early History of Yellow Fever, 1931), sums up the evidence, pro and con, as follows:- "Did Yellow Fever exist in this region at the time of the Spanish Conquest? If so, it disappeared entirely during or soon after that Conquest, and gave no evidence of its presence for over a hundred years. If this region, taken as a whole, was, up to that time, a permanent endemic focus of Yellow Fever, was there anything in the Conquest to make the disease disappear? One would think the contrary. The effect of movements of men in nasses is generally to spread infection, and the advent of the susceptible soldiers from the highlands of Guatemala and from Tlazcala and other parts of the Mexican plateau would specially have had that effect. True, one can conceive of a great increase of infection thus produced so completely immunizing a region that Yellow Fever is ultimately eliminated by that very increase. But there had been many wars

in Yucatan before, assumed to have no such effect; and certainly the effect of wars as we have seen them in Cuba, Mexico, and Central America in recent years has been to spread and increase Yellow Fever. I think, then, that we must conclude that Yellow Fever did not exist among the Mayas at this time, and hence that this region was not a permanent endemic focus of Yellow Fever.

To sum up, quite certainly the effect of the Conquest would have been :-

(1) to increase the prevalence of any Yellow Fever already existing in Yucatan, in Mexico, or in Central America;

(2) to increase the communication between Yucatan and the coast sections of the other two; and

(3) if any one of these regions were infected with Yellow Fever, to increase the danger of its communication to others, as every condition favouring infection was increased by the Conquest.

Therefore, and since, in fact, the Conquest having taken place, Yucatan was not infected for well over a hundred years thereafter, it is not reasonable to claim that it would have been infected during this time if the Conquest had not taken place.

The evidence then is strong - to my mind convincing- that at the time of the Conquest Yucatan was neither a permanent endemic focus of yellow fever nor a component part of a permanent regional focus.

That aegypti were prevalent in Yucatan in 1648 goes without saying - else there had been no epidemic."

In any case it seems to him (Carter) that with the data we have on Yucatan, one of the above conclusions (1) or (2) is inevitable, and the first must be accepted in any case since it is implied in the second. Nowhere about the Carribean do the pre-Columbain conditions for the breeding and existence of aegypti seem to have been so good as among the Mayas. If aegypti were not prevalent there during this time, obviously they were not indigenous to this region - they could not have died out - but were introduced later. If not indigenous to Yucatan, it is extremely improbable that they were indigenous to the Mexican littoral. That being so, YELLOW FEVER COULD NOT HAVE ORIGINATED AND BEEN PERMANENTLY ENDEMIC IN EITHER OF THESE AREAS.

In the last section of the Historical evidence we have come to the conclusion that from the time of the Spanish Conquest until 1648, we had no positive data, and that the native Mexican records were all negative.

Various epidemics were mentioned e.g. small-pox measles and a "Tabardillo" (probably Typhus or Scarlet Fever). Melina Solis Vol.1 page 130, mentions an unnamed "peste" in 1571, following a famine, and again in 1561, but nothing resembling Yellow Fever. There can be no doubt of the cause of the great epidemic of 1648 in Yucatan, and that it occurred in a susceptible community, proving that yellow fever had not been there before, or, at least, had been absent for a very long time.

None of these in their descriptions can compare with the account in Cogollude's "Histeria de Yucatan (1688, lib.xll, cap.12 et seq). He states "in the beginning of June the peste began in the city of Campeche and in a few days so pressed upon it that it was totally laid waste"

He notes that those who followed the Image in procession were killed, Indians as well as priests

and "those who died appeared the most healthy and robust".

In an unpublished report to the International Health Board I noted the same (Carr, March 23rd, 1925) general condition owing to the festival of Carnaval, held during the season of optimal meteorology. "The tribulation of the city was very great AS NEVER HAD IT EXPERIENCED SUCH A DISASTER.... In the beginning (Merida) "few of the friars died...when the peste was at its height few were sick...afterwards many sickened at once". This is to be noted as typical of the disease.

The extrinsic incubation period in the mosquito, plus the period of intrinsic incubation in man, would give this interval between the first few, and the many following.

The Epidemiology of Yellow Fever fits this description or, at least, some other insect borne disease:- "Pestilences are accustomed to be a common accident in other lands, which uniformly attack all, but it was not thus in Yucatan, which was the occasion of the greater confusion.

It is not possible to say WHAT WAS THIS MALADY, BECAUSE THE PHYSICIANS DID NOT RECOGNISE IT". The symptoms described leave nothing to add to those I have seen myself.

At first the natives were not attacked except "only those who were with them (the Spaniards) and those who went to the city. These went out touched with the malady and the most part died in their puebloes". "On this account the Indians said with boldness that the malady was a judgement of God, since they were only sick in the city and towns (of the Spaniards). "An Indian proclaimed that all the Spaniards had to die and that the Indians alone would remain".

The above is interesting in the light of what the disease is called by the people of Brazil behind the backs of the Americans, especially during that period, 1923 - 1926, when The United States was suspected of Imperialistic designs on South America.

It was called "Febre Patriotica" because it killed the foreigner.

"As to what I said, that the sickness killed the most robust youths the quickest, I will say .... that of the children of tender age whom the peste attacked in Yucatan, there were very few who died compared with the people of more advanced age". This observation is to-day of the utmost importance, and constitutes our greatest diagnostic difficulty.

The symptoms in children are so slight, as a rule, that many cases are missed and the disease well established in a locality before an unmistaken case is diagnosed, usually in a foreign non-immune adult.

To sum up the epidemiological points noted by Cogolludo:-

(1) Lesser mortality among children.
(2) Greater severity among the robust.
(3) Absence of a second attack.
(4) Delayed incidence and then sudden outbreak among the Friars and Indians.
(5) Newness of the disease to the inhabitants.
(6) Physicians did not recognize it.
(7) Previous healthfulness of Yucatan (other countries were accustomed to pestilences" it

was not so in Yucatan".

From these observations we may deduce that,

(a) Yucatan had had no epidemic of Yellow Fever since the beginning of the Spanish Conquest, 120 years before.

(b) That the 1648 Epidemic was Yellow Fever

(c) That it attacked in a virgin soil.

(d) That it must have been brought from outside.

Having established the fact that Yellow Fever existed in the New World, how was it brought, and who brought it?

To answer this, an account must be given of the history of the disease in parts of the incriminated area other than Yucatan where it was first so definitely described. Before the mosquito host was definitely settled by the investigations of the American Commission in Havana during 1900, the early writers, with the exception of Findlay, thought that Yellow Fever in Hispaniola (Hayti) was indigenous and caused by telluric emanations or local saprophytic, but facultatively parasitic to human beings, producing the disease in those

susceptible to it, but existing in places independently and remaining indefinitely unless destroyed by some natural agency as frost etc. This would date it to geologic times. Findlay believed that it was introduced by Carib Indians in 1495 from the mainland or other islands as Hispaniola had been previously free from it.

That no fever, or other malignant disease was reported among the Indians when the Spaniards first landed in 1492 makes this view improbable. Many epidemics are described pointing to Malaria, small-pox, famine with its deficiency diseases and other conditions familiar to Europeans. Particularly be it noted, that, <u>never until 1649 was there any mention of epidemic disease in ships</u> either lying in harbour or taking expeditions. The absence of such reports is of the <u>utmost significance</u>.

This completes our review of the history of yellow fever up to the year 1648, in which year, we believe, it made its first appearance in the New World.

To revert to the question, who brought it and

how? What change had occurred in the means or mode of communications, or the social conditions of the area?

Previously I remarked on the factor of the slave trade which had begun soon after the discovery of the Americas. It must be remembered that the slaves were mostly adults which means, if they had come from the West African endemic areas, that they were immune.

It must have taken a very long time before Aedes aegypti, transported in the ships either as adults or larvae, or even as eggs, could settle in their new surroundings and, as there would be very few docks or quays for them to lie alongside in the new ports, flight or other means of making the shore would be precarious. Coming ashore with the slaves, who would be half naked and with no gear, would be rare.

A few years before, and during the year of the Yucatan epidemic, a completely new factor in maritime communication began to develop.. This factor was such that it greatly favoured the conveyance of both Aedes aegypti and Yellow fever. Buccaneers, mostly French and English, but also

Dutch, began to attack vessels in these waters and also to raid the towns of the Spanish Main. Cogullude and Molina Solis report that pirates were very prevalent during 1648. A famous Captain, Jacob Jackson, sacked Champoton, a town well in the interior, having landed 1500 men. These piratical movements must have profoundly altered the social and maritime life of the region and placed it in both direct and indirect contact with West African ports.

Expeditions sailing for the Spanish Main, because of favourable winds, usually called somewhere on the West African coast for water and victuals, where they often remained a long time to repair, and pick up consorts separated on the voyage from Europe, an ideal way to collect both the insect and the fever.

Du Tertre (1667-1671 vol.1.p.421-22) states "during this same year, 1648, the 'peste' until then unknown in these islands since they were inhabited by the French, was brought here by some vessels; it began at St. Christophe, and in the eighteen months it lasted it carried away nearly

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one third of the inhabitants". It was brought by a vessel from La Rochelle, France, and most probably had first called at either the mainland or one of the islands of the West African Coast.

Throughout the littoral of the Carribean and in the Antilles generally, and spreading north to the coasts of the colonies of Spain, France and Great Britain as well as south to Brazil, and crossing to the Western coasts of Central and South America, Yellow Fever epidemics became common after 1648.

Findlay (Trabajos Selectos, 1912, p.122) states "From 1511, in the year Velasquez came with three hundred residents of Sto. Domingo to settle the Island of Cuba, to the year 1648 or 1649, in which its population increased to a little less than 30,000 inhabitants, in spite of having an important commerce and the generality of the vessels which sailed from Nombre de Dios and Vera Cruz for the Peninsula or for Sto. Domingo, touched at Havana, there was no notice that any of the inhabitants had suffered on its soil from the grave pestilences which, year after year were wont to afflict those who went to the ports of the neighbouring continent mentioned above.

The principle which we have to recognize that a locality has not suffered before from Yellow Fever.. IS THE APTITUDE WHICH THE GENERALITY OF THE POPULATION IN SUCH LOCALITIES MANIFEST TO CONTRACT THE DISEASE WHEN ANY EPIDEMIC OF YELLOW FEVER COMES TO INVADE THEIR TERRITORY FOR THE FIRST TIME. With its help we see corroborated our assertion that in the first hundred and thirty-eight years of the occupation of this Island of Cuba by the European race there has not been manifested in it the pestilence which immediately spread through the Island, from the year 1649 to 1655, and of whose nature there is no plausible reason to doubt that it was the same Yellow Fever which subsequently had come to establish here its kingdom."

This last observation by Findlay, and the way he has put it, is a poignant reminder of what would happen in the East with its non-immune millions.

After 1658, nothing further was heard of Yellow Fever in Havana until 1761, when it was reintroduced from Vera Cruz, and then it created havoc among the British troops under Pocock and Albermarle, who had captured the city. From then on it was permanently endemic until 1901, when, for

the first time, Gorgas finally banished it by control of Aedes aegypti. Once the city had become an endemic centre, disease among adult citizens was hardly noticed, the mortality was among the immigrants.

Children were so lightly affected that Gorgas used this fact to change his plan of attack, from the disease to its vector, in his compaign in Panama; the latter he could control, the former he could not, as it was seldom recognizable. All those recorded as having had Yellow Fever developed it within two and a half years of arrival, very few had it after the third year. It was known among the laity as the "fever of acclimatization". Almost all the other islands in the West Indies have a history of Yellow Fever, but one of the most deadly occurred in St. Lucia. Berenger-Feraud, quoting du Tertre, states:- "in 1665, an English squadron which was in good health took possession of Sainte Lucie, and placed there a garrison of 1500 men; by the month of January of the following year this garrison was reduced to 89 as the result of a violent epidemic of Yellow Fever". (op.cit.p.30).

Martinique in 1690 had an epidemic reported by Pere Labat (1722). It was brought from Recife, Brazil, by a French war ship, which had called there on its way from Siam.

In Brazil the disease does not appear until 1686, possibly because the mosquito had not had time to become sufficiently concentrated or because buccaneers were never as active on that coast, there being no attractive loot until much later.
Da Rocha Pitta gives an excellent account (Historia da America Portugueza.1730). It first demonstrated itself in Olinda, a residential suburb of Recife, then spread to Bahia, where it was severe, showing a virgin soil, and then died out from failure of the human host until reintroduced in 1849 from Havana or New Orleans.

The fleet of Gomez Freyre de Andrada, sailing from Lisbon early in 1685, stopped at the Cape Verde Islands, which even then were "notoriously unhealthy" and during the voyage from there to Brazil had had much disease and lost many of the crew. They put in at Recife for a refit and later the epidemic broke out.

Although the disease did not become endemic in the United States, because of climatic deterrents, there were yearly epidemics in the coast towns, and up the Mississippi valley. American expeditionary forces to Vera Cruz in 1846 "died like flies and during the campaign in Cuba 1898 -1900, had Spain not surrendered, indeed, it is almost certain that the United States would have had to withdraw its troops!"

I quote from "William Crawford Gorgas, his life and work" (Gorgas and Hendrick 1924):- "For two centuries the coast cities of the United States had served as its most promising hunting grounds. New Orleans, Mobile, Charlestown, Baltimore, Philadelphia, New York, New Haven, Nantucket Island, Boston and other places had many times satiated this voracious appetite. In none of these cities was Yellow Fever "endemic"; the disease could exist perpetually only in countries which were warm all the year round, for the frosts of autumn and winter immediately destroyed the cause; in most American cities, therefore, the Yellow Fever came as a summer plague, falling upon them with ferocity and disappearing almost as unexpectedly as it had appeared."

(It is interesting to note here that many unwarranted reputations were made by sanitarians of the days before Aedes aegypti was incriminated, who thought that their work had been the means of causing the disappearance of Yellow Fever when it was actually Dr. Frost.)

"The mortality from such invasions was always high. In 1793 a Yellow Fever epidemic killed 4,000 men, women and children in Philadelphia, or one tenth of the entire population."

"This was one of the worst visitations in American history, although no more destructive than the one that terrified the Mississippi valley in 1878, reaching its most alarming phase perhaps in Memphis". (State of Tennesse, almost 500 miles up the river and carried by boats.)

"Probably the Philadelphia epidemic of a century before owes its fame chiefly to the vividness with which it has been described. The famous Dr. Benjamin Rush and Matthew Carey have left accounts which have a strong resemblance to Defoe's description of the great London plague (Black Death)."

"Reading their graphic pages, indeed, one might fancy himself in the English capital in 1644-65."

"The same terror, the same panic in face of an unknown and impalpable enemy, the same manifestations of the worst passions of human nature, as well as of the best, mark the Philadelphia story of 1793 as they do the London visitation of the preceeding century."

"The situation continued until the appearance of frost, when the plague vanished as mysteriously as it had arrived, and the town again adjusted itself to normal conditions. One writer records, as an evidence of the popular frenzy that had ruled all summer, the delight with which the populace looked upon a conventional funeral proceeding in leisure and dignity through the streets. It had for so many months been the custom to hustle off unattended corpses at midnight, or to leave them unburied in vacant lots, that even this sombre manifestation of normal existence was a cause for general rejoicing."

It was particularily noted by Rush that "people who constantly associated with the disease

did not necessarily contract it while thousands who had never come near a patient dropped in their tracks". He notes yet again that "moschetoes" were very plentiful about Philadelphia in 1793 and Noah Webster describing the New York epidemic of 1795 states:- "mosquitoes were never before known by the oldest inhabitants to have been so numerous."

Such was the religious idea of the origin of disease in those days that the above two points of paramount significance in the epidemiology of Yellow Fever were entirely missed by a famous physician and the mystery only cleared up by his fellow countrymen more than a hundred years afterwards.

During the 19th. century not a year passed that did not claim its victims from Yellow Fever in many American cities, and the Philadelphia scenes were duplicated as late as 1878 in Memphis. In that year there were 100,000 cases with 20,000 deaths, in the United States, the last outbreak occurring in New Orleans in 1905, five years after the vector had been definitely established by Reed and his co-workers in Havana.

We had already noted that the invading English

and Colonial American troops who captured Havana in 1762 had to abandon the enterprise after a few months because of Yellow Fever, and in 1800 the pick of Napoleon's army which landed in Haiti had almost vanished after a year.

In George Town (British Guiana) 69% of the garrison died in 1840.

Crossing to Europe we find that the disease appeared time after time in various ports of Spain; Cadiz suffered five epidemics in the 18th.century and Malaga one. In the 19th. century the disease manifested alarming proportions, from 1800 down to 1821 Cadiz, Seville, Malaga, Cartagena, Barcelona, Palma, Gibraltar and other ports suffered severely as well as the surrounding country. In Barcelona in 1821 five thousand persons died. At Lisbon in 1857 six thousand died in a few weeks. Italy, France and even England (Swansea 1865) have not escaped.

From this survey it can easily be seen what a tremendous political factor Yellow Fever has been in the New World, from the Argentine to Quebec, and in the European Old World, its western coasts from England to Italy.

Let us now examine the other two regions which was decided could be a permanent endemic area, tropical West Africa. It was decided (page 10) that, biologically, the evidence pointed to West Africa as the origin of the disease and its vector.

HISTORICAL EVIDENCE.

The evidence produced, and the data examined, although negative, in the survey of the New World is, in my opinion, completely against the origin of the disease in that hemisphere. Ispo facto, we are reduced therefore to that other area which meteorologically and historically can produce the necessary conditions. It is not necessary to search beyond 1648 because it has been established that Yellow Fever was present at that time in Yucatan, and its presence in West Africa after that date could mean that it had been transported from the West.

The disease has never been recorded on the East Coast although entomologically and sociologically there is no reason that can be found, either now or in early times, why it should not have been there as it has in the West. Therefore we shall

confine our attention to the West. At once we must note that the evidence, both positive and negative, contrasts, rather than compares, with that of the Americas.

There are no native records in Africa such as we have of the Mexicans, Mayans and Peruvians before the Spanish Conquest. The history of voyages down the West Coast were good, such as that by Ramusio (Naviationi etviaggi. 3rd.ed. Venetia, 1485-1557) but they were of discovery only and had not the element of intense excitement engendered by the "New World" of Columbus. In the Americas there were large settlements made; in Africa only trading posts established.

These "posts" were at the mouths of large rivers and not up into the interior, while in the Americas, because of the healthiness of the plateaux, permanent settlement was made by the invaders who mixed with the indigenous peoples. In the islands off the coast actual settlements were made, and from them we can expect more definite data of disease, especially if that disease was not known to the colonists in their mother country, if the disease were already endemic an epidemic

would not occur. In the Americas the native suffered equally with the invader; this fact compelled notice.

The constant presence of malignant malaria, with the difficulty of differentiation from Yellow Fever, makes early accounts unreliable, and it was Schette (1778) who first definitely described an epidemic in a body of British troops at St. Louis de Senegal.

The most reliable criterion we have in such an area is a history of shipping after visiting ports in that area, especially if the disease continued to attack the crews at sea, but whatever is found we must not expect it to be the clear-cut evidence such as we have from the Americas with epidemics of frequent occurrence and high mortality.

EARLY HISTORY OF WEST AFRICA.

Much of the continent of Africa had been well known from the very earliest period of European history, but of that part of it which concerns us in our survey of the West Coast, in terms of Yellow Fever, there are no records until the latter part of the 15th century.

The east coast was early brought into communication with the Levant by Arab traders who founded settlements as far down as Madagascar in the 10th century, and there is on record, as early as 130 B.C. an expedition of Eudexus of Cyzicus; but nowhere can we find an account of a disease or of an epidemic which can, even remotely, be associated with Yellow Fever. Walckenaer (Collections de Relations de Voyages ..en.. Afrique 1842,vol.1x.pp.379-380) has examined very thoroughly all the legends and reports of the early historians regarding West Africa from Pharaoh Neche, 600 B.C. to the Dieppois, 1488 A,D, and concludes that the evidence given is not valid. We begin to have reliable evidence about the middle of the 15th century, from the Portuguese.

Ramusio (Navigationi et Viaggi, Venice 1564-83, vol.1.) recounts at length the various voyages, under the patronage of Prince Henry the Navigator, which opened up communications between Europe and West Africa from 1434 to 1455.

On 1488, Bartolome Diaz made his famous voyage round the "Cape of Storms" (Cape of Good Hope) and reached the Eastern Mainland above Port Elizabeth

and returned, followed by Vasco da Gama in 1497-1499, on his voyage to India.

The islands were discovered, or perhaps re-discovered, earlier. The Canaries, the only inhabited ones, by the Spaniards, in 1402, the others by the Portuguese, Madeiras 1418, Cape Verdes 1456, Soa Thome 1470; all became settled in the 15th. century and the communication between them and Europe was much greater than with the mainland, as also with the Americas because of the slave trade.

The first settlement on the continental coast was at Arguim, in the bay just south of Cape Blanco in 1488. It was a fort built as a base for the slave trade. Elmina followed in 1482 and Angola in 1490. Holland, France, England and even the State of Brandenburn continued these settlements, but they were mere posts, not colonies. Angola was the centre of the slave trade and had as many as four hundred and fifty men as garrison.

While the mainland settlements remained small, the islands rapidly became well populated with Europeans and developed into ports of great activity

with constant communication with both the West Coast and tropical America.

The logs of the Portuguese voyages were exceptionally well kept, especially those of Ca da Mosto in 1456. These have been quoted in Azurara's Chronicle (1841) and in Ramusio's Collection (1563-83). The second voyage of Mosto included an ascent of the River Gambia "for about sixty miles" to "the country of Battimansa"; it goes on to state "at the end of the 11th day we decided to leave and go to the mouth of the river, because many of us had begun to suffer with hot fever which is acute and continuous".

The word "continuous" seems to indicate Malaria more than Yellow Fever, but no further details of sickness was given, indicating that it could not have interfered seriously with the expedition.

Had there been the malignancy reported by later expeditions, with the inconvenience caused to their object undoubtedly it would have been noted.

The earlier visits were confined mostly to the coast and the vessels anchored off shore, while the latter, in which much sickness was reported, were up river for the purpose of trade.

Saco (op. cit.p.41.) quotes Bernaldez as follows " in 1471....the flotilla discovered a mine of gold on the 'coast of the black Xelefes'.. The major part of the crews became sick and died without remedy and afterwards, pursuing their voyages, the travel became easier and they became well and ceased to die."

Abstracts from English logs of the ships' voyages to West Africa, and the Gulf of Benin in particular, have been given by Walckenaer (1842) and Carter (1931) has examined the original accounts and states as follows:- "In particular all of these expeditions sickness is noted, and in some, the mortalities are excessive. For instance, in the expedition of Windham and Pinteado to Benin, in 1553 'scarcely forty' out of a hundred and forty men returned to Plymouth; and nearly all the deaths occurred within little more than a month, aboard ship lying at the mouth of the Benin River, dying 'sometimes three and sometimes four or five a day' (Hakluyt, op cit, vol.xl, pp 80-81). The loss in Newton's and Bird's expedition, also to Benin in 1599, was proportionally as great, and in as short a time. "It is worth noting that the ships of

Windham and Pinteado lay in the Benin River, near the mouth, while a party went up the river '50 or 60 leagues" to 'the King of Benin his court' to get their cargo (cardamons). All the sickness recorded was in the men who stayed with the ships."

"Such community mortality as these expeditions suffered, and in such a short time - hence not caused by recurrent attacks - is indeed extremely high for Malaria, even in West Africa, and it may well be that it, or much of it, was from Yellow Fever. This however, is the only evidence therefore, and one hesitates so to pronounce it."

In the history of these expeditions and in that of the early settlements we are confronted continuously with the poor accounts of the diseases which prevailed, and the difficulty of differential diagnosis between Yellow Fever and Subtertian Malaria, which pertains even to this day in the hinterland of Brazil and caused me much trouble and doubt in analysing reports from both poorly trained medicos and laymen. The <u>negative evidence</u> in Africa has not the same weight that the same had in the Americas. The conditions in the latter

were such that the presence of Yellow Fever was easily recognised and of such epidemic extent that it could not have been there before, at least not without being recorded, and it never was. The accounts we have may have been Yellow Fever, but we cannot be certain, so we shall turn to the history of the islands off the coast, which were true colonies, and with the exception of the Canaries, were uninhabited at the time of discovery.

The Aedes aegypti, even if not indigenous, must have been introduced early, and either with it or afterwards the disease, if it was present on the mainland. But even more than the islands, ships visiting them are more important as indicators.

SHIPPING.

Between 1599 and 1641 Sao Thome was twice captured by the Dutch, and both times the fleet of the invaders suffered a high mortality. Dapper, Barbot and Labat all mention these invasions, but there is the usual scant detail as regards symptoms and mortality. Dapper states:- "The Dutch had no little number of deaths and of sick men when they made themselves master of the island in 1641 under Admiral Jol, for there hardly remained 10 or 12 men

sound of each company, and Jol himself died, besides several other chiefs. Finally the malady raged with so much fury and it extended itself so among his men that there hardly remained enough for sentinels, and so few sailors that there was difficulty in equipping two vessels. The most part died of pain in the head so violent that it threw them into madness and folly. Some had a pain in the belly which carried them off in 3 or 4 days."

Barbot speaks of "this sort of Cholick" as that "it has swept away an incredible number of men ...It...with the bloody flux, killed such a number of Dutchmen the two several times they subdued the island, in the years 1610 and 1641, as before mentioned, that the island was then known in Holland by the name of the Dutch Churchyard."

Labat gives a similar account. The mortality quoted by Netscher (1853, p.121) from Dutch sources, says that of 600 men landed on the island in October 1641, only 230 remained in December. These data suggest Yellow Fever, both mortality and symptomatology.

Keeping before us 1648 as our key date for positive identification of Yellow Fever, we must conclude that up until the early years of the 17th century, we may only presume Yellow Fever in Africa from the indefinite descriptions given. There has been nothing like Cogolludo's description of the Yucutan Epidemic of 1648 which was certainly Yellow Fever.

Over a hundred years were to pass before Lind and Schoote made their reports of fevers in Gambia and Senegal which we can take as definitive. Lind, who was an authority on tropical diseases, wrote in 1768 a treatise on diseases of hot climates of which there were several editions, and we quote from the fifth. (Essay on Diseases Incidental to Europeans in Hot Climates, 1792). He gives several descriptions, but one is certainly Yellow Fever.

"During August 1768, the sloop "Merlin" with 90 men entered the Gambia River. She continued six days in the river, employed in wooding and watering. While there all the men were in perfect health, but in about two days after they put to sea, those who had been employed in wooding were successively taken ill, afterwards those who had been employed in

the duty of watering were seized in the same manner. At first these men alone were seized with the fever, and several of them a day continued to fall sick for six or seven days; at length almost all that had been employed on those services were ill; after them, their attendants were seized with the fever, and in such numbers as to leave no doubt of the disease being infectious" (Op.cit. pp. 184-5).

Here again the evidence is only epidemiological, no clinical description being given. The incubation periods in the men are correct and especially the fact of the attendants in the sick bay being affected later from Aedes infected from the first cases.

Lind himself thought it was malignant malaria and he quotes later in the same treatise from the log of H.M.S. "Weasel" clinical descriptions of what was undoubtedly malaria, confusing the two diseases. Lind also makes the observation, made a thousand years before by Roman writers, that malarial fevers were hardly ever contracted during the daylight, and concluded that this applied to Yellow Fever. This mistake has been responsible for many deaths in ships lying off infected ports, because in my own experiments I found that Aedes aegypti bite during every hour

of the day or night.

Schotte presented a report to the Royal Society in 1780 on the "Synochus Atrabiliosa" which he had studied in Senegal in 1778. He states that the garrison had been in fair health until early August when a "raging" epidemic began which lasted until the middle of September.

St. Louis de Senegal had 92 white inhabitants, and of these 59 died at the rate of 3 to 5 a day at the peak of the epidemic, which was the month's end. There have been many similar outbreaks since this report and epidemiologically they were the same.

It had taken 134 years after Cogolludo in Yucutan had definitely described Yellow Fever, for Schoote to make as definite diagnosis in Africa, although even then he was not certain with what he was dealing. Had he read Towne, Hughes, Bruce or Warren, on the disease in the Antilles, he could have recognised at once with what he had to do, for they had published in London before this period.

What was the cause of this lag?

It must be remembered that even at this present time the occurrence of an epidemic is often the first notice we have of the existence of the disease. In Yutucan the epidemic was noted as a new disease, attacking both foreigners and natives, while in Africa it was thought to be only an increase or exacerbation of a disease already present. In Africa it was the introduction of susceptible people into an already endemic locality. Schotte differentiates between his "Synochus Atrabiliosa" and the ordinary fevers of the country. He did not indicate that it was a newly introduced disease.

The history of the disease in Africa is more on a parallel with the history of troops sent out to the West Indies after Yellow Fever had become endemic there. Again, Africa has never been permanently settled by non-immunes in those parts which have endemic Yellow Fever; whereas the Americas were so from the beginning, and that means more, and proper, records were made of conditions affecting immigration.

From Schotte's time on, reports of yellow fever on the West Coast of Africa have been constant, sufficiently constant to deduce that the disease has

been endemic.

Intervals have occurred without reports, and we know positively that the disease has been introduced into Africa ports by ships from the Americas, but it has been demonstrated often enough in places which precluded any such means of origin. Also, this does not mean that every port or section has had the disease permanently, but that the disease has been present at some spot all of the time; constituting a regional focus in West Africa long before it spread to the Americas.

The disease has been one of European settlements or ships touching at the ports, and very seldom mentioned as affecting natives, which does not mean that natives are immune to infection, but that they do not suffer recognizably. We have this in the native white peoples of endemic America, who are under modern methods of observation (such as has never been the case with the large majority of the native Africans), and for the same reason.

It is an established fact that the Negro has both a racial and specific immunity; he is resistent to the toxins although not to the infection, with much less reaction and markedly less mortality.

Negroes in the southern United States, where no yellow fever had been before, suffered much less than the whites when an epidemic did occur; and we have the classical example of the half-white, half-black brigade, sent to Mexico by the French in 1862 from Kordofan, which had never known yellow fever. The blacks enjoyed "almost absoulte immunity" and no mortality, while the whites suffered severely.

The disease therefore, is propagated by the Negro, especially the children, who because of the mildness of the attack, are not noticed. The whites are not in sufficient numbers to provide for endemicity, therefore are merely the indicators of the disease among the blacks.

From this survey of the early history of Yellow Fever, we may now come to some conclusion as to its origin.

The first recognition of the disease as an entity was in the Yucatan epidemic of 1648, and we decided that as it attacked the native as severely (or even more severely) as the white invader, it could not have been endemic, at least for a very long time.

The native and Spanish history from the time of the conquest had given no indication of its presence until 1648, and nothing before. It was a new unknown disease.

The length of time from the Conquest to the first epidemic was undoubtedly due to the fact of the absence of the vector in sufficient numbers, although communication between Africa and America had been constant for more than 100 years. So also, in those other parts of the World where conditions are favourable for the propagation of the disease and vector, as in parts of Asia and East Africa, one or other of the three essentials must be lacking. The virus, functionally active vector, or non-immune population in sufficient numbers. In these other regions it must have been the absence of the virus, as both men and vector are abundantly present.

Our conclusion therefore is, that the West Coast of Africa is the place of origin of Yellow Fever, at least as far as mankind, as we know him at present, is concerned. Whether West Africa was the place where Yellow Fever first evolved as a human disease cannot be determined, for we know almost nothing of the evolution of man and his parasites.

The next great landmark in the history of Yellow Fever was the discovery and proof of its means of vection. This fundamental factor in control was the discovery of the vector in Aedes aegypti.

In 1881, Carlos Findlay of Havana had read a paper before a medical congress in Washington U.S.A., making the assertion that Yellow Fever was caused by the "Stegomyia" mosquito. He asserted in vain, was, in fact, laughed at and discredited as a crank by many learned societies and tropical experts.

Meanwhile Manson had discovered in 1880, the vector mosquito of filariasis. In 1889, Smith and Kilborne proved that Texas fever was transmitted by a tick, and Ross in 1897 demonstrated that Anopheles was the infecting agent in Malaria.

These discoveries brought a new interest to Findlay's theory, which had lacked proof because of the yet undiscovered fact of "extrinsic incubation", which Carter found in 1898. The Spanish-American war was the opportunity offered to test all this during the occupation of Havana by the United States' troops, who were being attacked by Yellow Fever.

In 1900, a scientific commission was appointed to study the disease. Here in Havana were the four men who were to solve the Yellow Fever mystery which had baffled the doctors for centuries and caused the loss and misery of millions, as well as altering frequently the politics of the powers in their colonial ambitions.

Findlay, Carter, Reed and Gorgas together, with theory, experiment and practice ideally proved that Yellow Fever could be banished.

A description of this work will be given in another section.

For the 140 years, from 1762 until 1901, Havana had not been free from Yellow Fever for a single day. Every year had had a record of death. For the ten years before the American occupation the average mortality was five hundred per annum. In 1896, the deaths were 1,282; in 1900, the year preceding the work of Gorgas, 310-- and those at the beginning of an epidemic which his control methods stopped.

Control was started in March 1901, and the deaths subsequent to this were exactly five during July and August.

Apart from a small outbreak in 1905, which was promptly checked, thirty-two years have passed without a single new case being reported in this city, which had been the peste's main headquarters in the Antilles.

This Epical, and Epochal demonstration marked the beginning of a series of successes in the control of the disease in those regions where, heretofore, it had held undisputed sway.

Panama had been a byword for many generations, in terms of Yellow Fever.

In 1904 the United States, having taken Panama from Columbia, began to build a canal.

In William Crawford Gorgas, His Life and Work (1924) we are told, "There was one man however, who knew that American wealth, American engineering skill, and American energy would not in themselves accomplish this great programme . . . The Doctor's papers at that time disclose the general failure to grasp this great truth".

Gorgas appealed to the Washington Authorities pointing out the importance, before all else, of the application of the new methods of sanitary control.

It states that Gorgas wrote to the Surgeon-General, "to the enormous loss of life that had been caused amongst the French working at Panama, due to tropical diseases; that by far the most important of the diseases were Yellow Fever and Malaria; that if we could protect our labourers on the canal as we had the people of Havana, we should be able to build the canal without anything like such losses as had occurred to the French."

That the French had suffered notoriously was well known on the spot, but had been carefully hidden from the shareholders, with the resultant scandal and complete failure of the attempt.

Anthony Froude wrote of Panama in 1885, "There is not perhaps now concentrated in any single spot so much swindling and villainy, so much foul disease, such a hideous dungheap of physical and moral abomination. The Isthmus is a damp, tropocal jungle, intensely hot, swarming with mosquitoes, snakes, alligators, scorpions, and centipedes; the home, even as Nature made it, of Yellow Fever, Typhus, and Dysentery."

Ships had special instructions for approaching Panama.

De Lesseps, the French Engineer-in-Chief, when first he began work in 1881, was told by the French resident, Le Blanc, who tried to dissuade him from his attempt, "If you try to build this canal, there will not be trees enough on the Isthmus to make crosses for the graves of your labourers."

"Why, do you really wish to commit suicide? To go there is to run to your death." "Death," he reported, "was constantly gathering its harvest about me". "Funeral trains are as much an institution as passenger or freight trains."

"Since the advent of De Lesseps' canal-men on the 28th of February, 1881, thousands upon thousands have been buried there, (Monkey Hill Cemetery)". "During two

seasons of epidemic it is said that the burials averaged from thirty to forty a day, and that for weeks together." "A not unusual sight during the French period was a ship riding at anchor in the harbour of Colon, with not a soul on board; every member of the crew had died of Yellow Fever."

Gorgas calculated that the French had lost one-third of all their white employees, - a total, in eight years of 20,000 lives. "Had the sickness rate of the French prevailed when the Americans were at work, we should have had about 13,000 men in hospital constantly, and, had their death rate prevailed, we should have lost not far from 3,500 men a year. As we were 10 years in building the canal, this would have meant the sacrifice of 35,000 lives. The humane sentiments of the American people would not have tolerated such a slaughter."

When Gorgas first went to Panama, there was no sign of Yellow Fever, for it must be remembered that this was an endemic focus, and after the French failure, there had been almost no fresh immigration to show it up.

Because of this apparent absence of the disease, the Engineers and Contractors who followed, thought that Gorgas was a fanatic, and every obstruction was put in the way of his endeavours to protect the work.

Soon, sporadic cases began to be seen, but as yet no large outbreak. Then several members of an Italian Opera Troupe caught it and two died. This was the signal for a general epidemic all along the line.

The scenes of panic were enacted, as they had been for hundreds of years. "The canal force .. seemed to be possessed of one single view - to start for home." "When several American officials died at Ancon Hospital, the desire to get away became almost a frenzy." "There was only one reason why they did not get away en masse, and that was the lack of shipping space to carry them." "At that moment the American adventure was tottering on precisely the same brink that had destroyed the French."

"The real meaning of this epidemic was that the United States could not build the canal."

Due to the crass stupidity of both Medical and lay authorities on the Canal and in Washington, Gorgas was relieved, and was only reinstated by President Roosevelt, acting as a DICTATOR over the head of his Minister of War. That action of the President's saved the canal, for in 1906, the last case was seen.

At the last post mortem Gorgas said, "Take a good look at this man, for it is the last case you will ever see. There will never be any more deaths from this cause in Panama."

A four hundred years' scourge had been wiped out by a campaign of less than six months. It was the greatest triumph yet won by preventive medicine.

On August 15th 1936, The Straits Times of Singapore published an article by the writer, in which I said, "Few realize that the Panama Canal is not a monument to an Engineer, but to a sanitarian. General Gorgas was not primarily a scientist; he was a Master Controller."

"Little did Gorgas know that by the very ease with which he cleaned the Canal Zone, he was making the path of the Yellow Fever Sanitarian a thorny one. Given the same conditions of unlimited money, bayonets, and a fixed territory, one could clean the world of disease."

"Those who have followed in Mexico, South America and Africa, know by the thinned ranks and the heartbreaks, the almost insurmountable difficulties which are encountered when an ignorant, and sometimes antagonistic populace have to be dealt with and begged to co-operate for the saving of their lives."

After 1906, the encouragement given by these two demonstrations in Havana and Panama, caused a wave of enthusiasm among those nations where, for so many years, there had only been dumb acquiescence to both the endemic and epidemic status quo.

In Rio de Janeiro, where 28,078 persons had died in the

thirteen years before 1906, only forty-two died in that year, thirty-nine in 1907, four in 1908, and none in 1909.

The cities of tropical South America, Central America and Mexico were put under control to the extent of causing the disease to disappear for long periods, or rather, to go into hiding, for the reasons I have stated as regards imperfect control in terms of the difference between military and civilian authority.

Up to this date small outbreaks have occurred all over the old area, but were promptly extinguished as soon as the officials were sufficiently aroused. In the United States, during the epidemic of 1898, although every known control method was employed, including rigid quarantine, there were 13,817 cases and 3,984 deaths, in New Orleans.

Because of official slackness and actual obstruction, nothwithstanding the work of their own sanitarians, this same city had another epidemic in 1905, with 3384 cases and 443 deaths.

This was the last epidemic in the United States, but it must be emphasized that it only ended with the frost, demonstrating once again the stupidity of authorities who at that time had complete knowledge of the means of control.

In the West Indies, the military records show that Yellow Fever had been continuously present in all the islands

up to 1846.

After this period, a fundamental reform took place in the shape of a piped water supply. This type of supply cuts at the very root of Yellow Fever if the supply is constant, while it actually increases it, if intermittant.

In the islands it was the former, and after 1850, Yellow Fever ceased being endemic and became an imported disease from the great endemic foci.

The disease has not appeared since the Great War, and undoubtedly the cause was the restricted inter-island trade due to shortage of shipping during the War. The history of the disease in West Africa since the discovery of the means of control has been similar to the Americas. First enthusiasm, then a slacking off, but the conditions of endemicity in West Africa are very much more complicated than in the Americas, of which I shall have more to say in the section on Epidemiology.

From St. Louis, on the northern Senegal coast to Fernando Po off the coast of the Cameroons, Yellow Fever has been demonstrated repeatedly up to the present.

It must be remembered that we have decided that the disease originated on this coast or in the hinterland, and therefore has <u>always been ENDEMIC</u>, and that the negro has a racial immunity which has allowed the disease to remain unrecognized until shown up by the introduction of non-immunes.

Little interest and attention has been given to the danger, as the country has never been permanently settled by Europeans, as in the Americas. To complete the Historical Survey and note the present Geographical Distribution, I give the figures in the last "Public Health Reports, United States Treasury Department, April 23rd. 1937".

"BRAZIL - Cases reported, 125.. Deaths, 67 (by the Viscerotome Method, post mortem).

A few cases each from Columbia, South America, and Dahomey, French Equatorial Africa, Gold Coast, Ivory Coast, Nigeria, Senegal, Sierra Leone, French Sudan; fourteen cases with seven deaths on board S.S. "Sea Rambler" out of Dakar bound for the River Tyne in England."

The last landmark in the History has been the discovery of the Causative Agent.

Yellow Fever has come out into the open where we have now a fair chance in the fighting of it. It would be more correct to say that all the many organisms which have heretofore been blamed, are now exonerated, and the cause definitely proved to be an ultra-miscroscopic virus. It has been proved in 1900, that the virus would pass through a Chamberland F Filter, but in 1928 Stokes, Bauer and Hudson carried the experiment to finality and went on to develop

both a vaccine and serum.

The details of these experiments and their consideration, in relation to control, awaits another section.

It might be asked why so much space has been given to the historical section.

As stated in the introduction, the reason for the Thesis is a desire to bring into prominence the very serious possibility of disaster in the East, especially in relation to British interests.

From West Africa as the original endemic focus, we have seen what happened to the Americas when the vector and virus were introduced to a non-immune people. There it took more than 150 years to become dangerous for the reasons described.

It could be likened to a slow-burning damp wood fire.

The East, with its enormous non-immune population, BUT WITH THE VECTOR ALREADY THERE, AND WITH THE POSSIBILITY OF THERE BEING MORE THAN ONE VECTOR, WOULD EXPLODE LIKE A PETROL DUMP were the match of the Virus thrown into it, either in the form of an Aedes Aegypti during its infective stage, or a human in the infectious stage.

The panic, mortality and economic disturbance of Yellow Fever caused in both Africa and the Americas has been described at length, and I am of the opinion, from my experience in Central and South America fighting the disease, and from my observations and studiesin India, Malaya and

other Eastern countries, that all these conditions would be increased a hundred fold, with a repercussion fatal to our Empire.

End of Section on History and Geographical Distribution.

E P I D E M I O L O G Y.

Carter, (Early History of Yellow Fever, 1931), began his first chapter with this statement: "Yellow Fever is contracted by man in nature from the bite of a mosquito, Aedes (Stegomyia) Aegypti (Linnaeus), itself infected by having fed on a man sick of that disease, and, so far as known, is in nature only thus contracted." However, in 1927, Stokes, Bauer and Hudson (1928 Am.Jour, Trop.Med.8:103) working on the West Coast of Africa in the Yellow Fever Commission of the Rockefeller Foundation, began a new era in our knowledge of Yellow Fever, by showing that certain Indian Monkeys were easily susceptible to infection. Their work also finally exploded the Noguchi fallacy as regards "Leptospira Icteroides" blind adherence to which had put the clock back for many years in terms of both laboratory and field work. The impetus thus given has resulted in an enormous increase of our knowledge from every aspect, some of it encouraging, but much of it adding to our already profound dread of its spread.

In order not to confuse the issue this part of the section will confine itself to the epidemiology of the disease as it was known before these new discoveries, because, notwithstanding, THE PHILOSOPHY OF CONTROL HAS NOT CHANGED.

The enemy, and the forces required to combat him remain the same. The new era has unearthed entomological

auxiliaries to the old enemy, extension of his range, but by the same token, has greatly augmented our armamentarium, especially the intelligence service.

The newer knowledge will be discussed at the end of the section.

The first requisite in the epidemiological cycle of yellow fever as a disease of humans, with the exception possibly of the newly discovered "Jungle" type of small importance, is a man containing the virus in his blood. The second requisite is the presence of Aedes Aegypti Mosquitoes living within the optimum range of temperature and humidity; optimum, both for itself and the contained virus. The third requisite is another man who is susceptible, and the mosquito living long enough and having access to both. These factors may now be considered separately.

THE VIRUS IN THE FIRST MAN.

The virus of Yellow Fever, producing as it does, strong anti-bodies in the blood of its victim, and, should he survive, conferring a lasting immunity, can only continue to exist if the mosquito is present under the conditions stated, susceptible men are available while they are infective, and more mosquitoes present to convey it to more men.

From this it follows that, if either of the latter factors are not present, susceptible humans or active

mosquitoes, the virus must die, and cannot be reintroduced even if both mosquito and susceptible humans are again present, without a fresh first requisite.

Carter, (1901, Med.Record.59; 933-937) introduced the term "Extrinsic incubation" and in (Trans.Soc.trop med. and hyg, 10:119-129, 1917) another paper some years later, described the "spontaneous disappearance of Yellow Fever from failure of the human host."

These studies explained how Yellow Fever had so often died out in the West without any interference by man, and also postulated that in those specific places, there was no other animal than man which was infective to the virus.

If the virus exists only in the human, it could continue in the host for the period only of the incubation, plus the period of active disease, during which it could be transferred to a mosquito.

In actual experience in the field, these periods combined, equal nine days. If, however, the mosquito only carries the virus, and the third requisite, the susceptible man, is lacking, the virus would live a long time.

Many experiments have proved that the mosquito is infective during its entire life, and that although it is improbable that the insect, in nature, lives as long as in captivity, the longest time recorded must be taken as its longest infective period, i.e. five months. During this

period, were requisite number three present, the disease could be continued.

In the field, epidemics which are being fought by the sole method of destroying the insect in its larval state, are usually terminated in about six weeks of intensive work.

THE SECOND REQUISITE, actively functioning Mosquitoes.

Such a mosquito must be able to move, eat, rest, and propogate normally.

Both sexes must have proper temperature and humidity, and the female, the proper place to deposit her eggs.

The Pasteur Commission to Brazil in 1903 (Marchou, Salimbeni, and Simond,. Ann.de l'Inst.Pasteur, 17; 665-731, 1903) found that the lower limit for feeding was 18°C. and the upper, 39°C. The limits of breeding are slightly less, but it is the feeding limit that is of sanitary importance. As in all the Insecta, the higher the temperature and the less moisture, the more incompatibility with continued existence. This may explain the absence of Yellow Fever from the East in terms of the transport of infected mosquitoes, as the upper limit of temperature is far exceeded in the areas through which their conveyance could be affected, and also the lower limits of humidity.

The modern air transportation will render this temperature-humidity barrier ineffective. Hibernation

occurs in the egg stage. The eggs are laid above the water line and remain there dry after the water has receded from any cause, such as evaporation. Viability is retained for as long as six months in my own experience, (Jameson-Carr, Experiment No.13, Unpb.report,Rock,Found, 1924) and that the necessary male-female emergence time is retained (Jameson-Carr, Exp.No.7.Unpub.report,Rock.Found.1924). Males emerge first and are therefore ready for the sluggish, still damp female, who is caught on the wing before she can escape, when copulation takes place; the male being smaller and weaker might not get another chance.

Although the imago dies quickly below - 0.C. the larvae and eggs will stand freezing for a short time with, however, much lowering of viability. (Marchoux, Salimbeni, and Simond. Ann.de l'Inst.Pasteur, 1903.) In practice, it must be remembered that viability may remain unimpaired in the temperature of the house, although the outside temperature is inimicable, the Aedes Aegypti being in its normal habitat within the house, hence the old name Stegomyia, from the Greek, Stegos, a house, Muia, a fly.

BREEDING PLACES.

This subject was thoroughly investigated by the Author during 1924 in Parahyba do Norte, Brazil (Jameson-Carr,Exps. Nos.1 & 22.Unpub.Reports,Rockefeller Foundation,1924). These experiments were divided into three parts.

First Part. - Laboratory experiment with common containers, as to preference.

Fourteen containers were tested, being one of each type found to contain larvae in the city. New plain wooden barrel, wooden barrel lined with cement, new earthenware jar, empty dry coconut shell, tin can, iron can, copper can, porcelain toilet jug, flower pot of earthenware, flower vase containing flowers (glass), agate spitoon, zinc can, aluminium can, thin necked earthenware water bottle.

A large room was completely sealed and made as much like the ordinary room of the city house as possible.

Seventy-five females and twenty-five males, bred out in the laboratory, were placed inside, together with fruit, both dried and fresh, and at intervals of four hours, I entered to give a blood feed. Special precautions were taken to thoroughly clean the containers with boiling water and scrubbing.

Two days after this, eggs were seen to have been laid inside the plain wooden barrel, above the actual water line, but within the line of damp wood which extended by capilarity 1½ inches above the water.

In two more days, the first larva was seen. All the other containers were negative. The barrel was now removed and again thproughly scalded and scrubbed and filled with water to be sure no eggs remained.

This was replaced and exactly the same phenomenon occurred.

The insects immediately laid on the sides while the other containers remained negative.

This barrel was now removed entirely, the plan being to remove each container as it was chosen by the mosquito.

The order of laying thereafter was as follows: -

Coconut, Flower jar (with flowers), Red earthenware water jar, tin can, cement-lined barrel, zinc can, iron can, spitoon, porcelain water jug, copper can, flower pot (glazed), aluminium can, thin-necked water bottle.

All these took from ten days in the Red earthenware jar, to twenty-one days in the Spitoon, to complete the cycle, with the exception of the zinc, iron, copper and aluminium, in which the larvae only reached the second moult in the first three, when they died; and in the copper where they did not hatch at all. The order of laying was as above, but not the order of hatching, for the reasons for which the original report may be consulted.

This experiment appeared to show that <u>if forced</u>, the Aedes Aegypti female will breed by depositing her eggs on the edge of water in at least any of the containers found commonly in the habitations of Parahyba, but has distinct <u>preferences</u>.

The preference for the wooden barrel can be explained,

not in terms of the water in the container, but in terms of the surface above the water.

The mosquito's instinct places her eggs where they have the best chance to stick, in this case on the rough wood and within the capilary line where they have the opportunity to wriggle down to the main body of water, which, in wooden containers, was found to evaporate much more slowly than in those of other types. (Jameson-Carr, Exp. No.10. Unpub.Report, Rock.Found. 1924).

Second Part.

Observations as to the type of containers found to contain eggs or larvae in the field, in a town under control, the index in the city being 2%.

Third Part.

Observations with these containers found to be, in the previous experiments, common foci, but with special containers supplied by the Department, and in a district which had never been worked, and in which the mosquitoes and the inhabitants were without interference.

These observations and experiments covered one year's work, and the conclusions were as follows: -

CONCLUSIONS.

(1) Aedes Aegypti, in both controlled and uncontrolled areas,

show the same predilection as regards oviposition.

(2) The relation of the number of containers, in terms of the percentage of foci, does not alter in controlled and uncontrolled areas.

(3) Field work does, and should, confirm Laboratory work, if the latter is done in strict conformity with the former.

(4) The mosquito has herself shown the type of breeding place which she considers IDEAL.

(5) Her ideal is a container which gives her a surface upon which to deposit her eggs, and where they will stick, with no consideration of the water content.

Other observations and conclusions in this experiment will be referred to in the section discussing control. In Experiments Nos. 6 and 18 (Jameson-Carr, Unpub.Report, Rock. Found.1924) I was able to show that Aedes Aegypti would breed in a mud puddle only under extreme artificial conditions of forcing, but that under natural conditions they would not, also that after three years of searching, I was unable to find a single instance of that insect breeding in the axils of plants, although it had been often reported. I am of the opinion that the reason why Aedes Aegypti prefer man-made containers and has, as its natural habitat, the interior of man's dwellings, is, that she prefers human blood, as whenever I entered their cage they immediately

left any other animal on which they were feeding - cat, dog, hare - and bit me. Of these three, the hare was her choice and was used in most experiments, (Jameson-Carr, Unpub. Report, Rock.Found.1925). It is well known that animal screens are used in malaria prevention where it has been shown that certain animals are preferred, by certain Anophelines, to humans.

The Third Requisite, the susceptible other man.

The susceptible man, accessible to an infected mosquito, is the final factor in the continuance of the disease.

It follows that, as immunity is the consequence of survival, a degree is reached where no man susceptible is available to an infected mosquito, and the disease will die out, this process being known as "failure of the human host" (vide ante). Since both the man and the mosquito are necessary, it is not essential that all susceptible men have been eliminated by infection, as infected insects may be few in their vicinity either because there are few men left to convey infection, or a temporary or permanent reduction in the actual numbers of mosquitoes.

Under the law of chance, it is therefore not necessary to exterminate aegypti to eliminate Yellow Fever from an infected area.

It will die out from failure of a sufficient number of vectors.

This reduction to a failure-point in numbers of mosquitoes is called the "critical index" and must vary in relation to the susceptible men present; being less as the susceptibles increase.

In like manner the number of susceptibles in an area compatible with "elimination by failure of human hosts" must vary inversely, more or less, with the number of active aegypti.

In planning a campaign against Yellow Fever, it is important to realize that the "Critical index" is not the same even in different areas in the same town or community, (Jameson-Carr, Unpub.Report, Rock.Found.cap.10.1924). The native sections of a town are apt to retain an immunity regardless of the continuance of an index above critical, while the sections where non-immune strangers congregate are a very different problem, and much more dangerous. The size of a town or community is of less importance than the number of susceptible immigrants - which includes new-born babies.

Both these factors usually increase together, and this has been amply demonstrated in the history of Yellow Fever in Havana, Rio de Janeiro and Panama, where the disease did not die out spontaneously, they all having, over many years,

a continuous immigration of non-immunes.

The fact, that in many areas the disease has spontaneously died out, is a strong piece of evidence that immunity is permanent. In 1917, (Carter, Trans.Soc.Trop. med. & hyg.1917), introduced the term "regional focus" to describe an area of small communities too small in themselves to remain permanently infected, but in sanitary communication by means of travel. In such a group of areas, the mechanism of spread would be slower than in more congested communities such as towns. By the same token, elimination would be slower.

One such type of area was the interior region of Bahia (Jameson-Carr,Unpub.Report. Rock.Found. May 22nd,1926). It had been hoped, and expected, that by merely eliminating the disease from the main endemic focus in the capital of that state, that the interior would "burn itself out", but that did not occur, and after three years' work, cases continued to be found progressing from small village to small village.

In fact, this region was a permanent endemic regional focus.

In the interior of West Africa we have a like condition at the present time, and up until 1917, the south shore of the Caribbean and the Lesser Antilles could be so defined.

The disease died out in the latter owing to the great diminution of inter-coastal and inter-island communication

during the late Great War, this, through failure of the human host, not absence of the mosquito vector nor control. Yellow Fever is present always at some place in these regions and before one place can free itself by "failure of the human host" another with sufficient susceptibles becomes infected, and again the first place becomes reinfected when enough immigrants have arrived in the shape of non-immune strangers or babies.

Travel is the necessary factor in keeping the disease alive.

The contrast between a permanent regional focus and a town is, that in the former the spread is by means of infected men, while in the latter, it is by infected mosquitoes.

Distribution and means of dispersion of Aedes aegypti.

In the section on History, the conclusion was reached that all evidence pointed to West Africa as being the area of origin of Aedes aegypti.

In the first part of this section the conditions favourable to the life of aegypti were given. From whatever point of origin, the insect has travelled far, and the means have been human.

Preferring, as has been shown, both domestic association with, and blood of, humans, it can easily be seen that by

human agency its dispersion has been effected.

From a study of the preferential breeding places, it is obvious that the conditions aboard a sailing ship were ideal, especially in hot climates.

Drinking water carried in artificial wooden containers, or bilge water in ships plying on rivers, accessible to the insect, were exactly what she needed.

Only recently has this means of water carriage been supplanted by iron closed containers in the modern ships, but in the East, in the coastal trade, the old method still obtains, and there I have found them in abundance, as lately as September 1936, (Jameson-Carr, Unpub.Report. to Med.Off. of Health, Penang S.S.).

Not only could the mosquito gain access to the water container of the ship lying alongside, but a usual method of watering ships was, and is, to carry on board a container (Barraca) already seeded either with the larvae or eggs of the insect.

The ship would thus be a floating host from which the mosquito, in any of its three stages, could fly or be carried ashore at another port.

If the necessary conditions for propagation were found at another port, a new colony would be founded from which new dispersals could take place.

Were conditions unfavourable, e.g. low temperature or excessive dryness, there would be no propagation.

At the present time Aedes aegypti are found in every port, both sea and river, where conditions are suitable.

Although the above is undoubtedly the usual means of dispersion, I have often found in Brazil the drinking water tanks on railway coaches containing larvae of aegypti, and as the poorer people carry their own water in the ordinary red earthenware bottles from their houses when they travel, there I have found both larvae and eggs.

Household furniture, baskets of vegetables and even personal clothing, have been shown conveying the adults from place to place.

When the insect - whatever stage - is planted in a new spot, the natural dispersion is slow because of the short flight of the female who only moves if immediate blood (human) is not at hand.

Conditions required for the permanent existence of Aedes ageypti.

These are two: -

(1) Suitable breeding places.

(2) Suitable temperature and humidity.

The first depends on the domestic water supply and its means of storage.

There are three general types of community in terms of domestic water supply: -

(a) Where all the domestic supply is derived from a reservoir and conveyed to the outlet in pipes, the supply being constant.

(b) The supply is from a reservoir and piped, but intermittant.

(c) A natural and primative supply from raimwater, wells etc.

The first precludes the necessity for storage, and being always covered, prevents the female from having access to it.

The second, being intermittant, compels the inhabitants to store their water in various containers, usually uncovered, therefore allowing access to the mosquito.

The third is similar to the second, but with this great difference; those with an intermittant supply fill up their containers while they can, and they are usually numerous, while those who have to draw from wells or rivers only procure enough for their daily needs.

I have seen a battery of 200 large jars in a cellar in Parahyba do Norte, Brazil, each one containing a focus of Aedes aegypti, larvae and eggs.

From this, it can be seen that each locality is a law unto itself.

A piped, constant water supply is concomitant with advancing civilization and has been used to combat Yellow Fever

without other means being employed, e.g. in Santos, Brazil, which was of old a veritable hot-bed of the disease.

Shortly after a modern water supply was installed, the disease automatically disappeared, there being no further need of using artificial containers giving access to mosquitoes. In terms of control, the second type of community is the more difficult, (Jameson-Carr, Unpub.Report, Rock.Found.1925).

Temperature and Humidity.

The limits of these two factors in permanence of the species is determined by the position of the region in terms of latitude, between 38 degrees North and 35 degrees South.

Altitude affects temperature, especially at night, no less than latitude, and must be taken as one amongst a variety of variants, e.g. wind, ocean currents, and the difference between house temperature and that outside.

Carter, (The Early History of Yellow Fever, 1931) states the position as follows:-

"From what has been said of the biology of this insect, there are evidently two conditions of temperature, both of which must obtain in any region for the continued existance of aegypti in it:

(1) The low temperature of winter must not be so low or so prolonged as to destroy the species - the hibernating

eggs.

(2) The high temperature of summer must be sufficient for the development and reproduction of the insect. The natural life-zone of the species, the region in which it is permanent, so far as temperature is concerned, includes all regions in which both of these conditions are fulfilled, and none other."

Geographical distribution and dispersion of the disease.

The dispersion and distribution of Yellow Fever depends on the dispersion and distribution of the virus and active aegypti at the same time in the same place.

The means of dispersion of the virus, in infected men and mosquitoes - and it has no other existance of importance - is the same as that of the insect as discussed above, i.e. human transport.

There are differences in detail depending on whether the virus is in infected mosquitoes, infected men, or combined.

Infected Mosquitoes.

The description of the dispersion of the uninfected insect covers also the dispersion of the infected one, with, fortunately, this difference.

The mosquito does not pass on her infection to either her eggs or larvae.

The infected insect may infect men in transport, or may not, depending on whether it has access to them, has passed the stage of "extrinsic incubation" or encounters only men already immune.

It may arrive at the destination without having conveyed the disease. Having arrived, its further destiny depends on the conditions present, breeding places, temperature and humidity, and the presence or not of susceptible men.

Whether it remains there permanently, or only temporarily, depends on the temperature primarily, but with the other variants having their influence, as already discussed.

In the case of ships, the original infected insect may die, or be blown outboard, after infecting men, who can then infect insects breeding on board, the infected insect having deposited eggs in unprotected containers.

The limit to this cycle is only obtained when all the men are either immunized or dead.

Infected Men.

If there are infected men on a carrier (after the first three days of the disease) secondary cases will occur only if there are present uninfected mosquitoes who live beyond the period of "extrinsic incubation" and then bitten other non-immune men.

This may take place either on the same carrier, if the voyage be long enough, or ashore after arrival.

If there are no active vectors on board, or the infective men are only in the stage of incubation, the disease will not spread.

The final result will depent on whether the sick man is over the stage infective to mosquitoes when he goes ashore and the state of activity of the mosquito there, if he is not, whether the conditions will allow of the planting of an endemic, or only an epidemic focus.

Dispersion by Man and Mosquito combined.

In the days of sail this was the usual means.

If the vessel bred mosquitoes, and the climate was suitable, she carried infection to her destination, either in man or mosquito.

If she did not breed mosquitoes, the fever died out when the infected insects were blown outboard or climatically killed. On reaching port, she was free from the virus.

If a carrier did not convey mosquitoes, a twelve day voyage would preclude the introduction of the disease on arrival. This length of time includes the maximum incubation period plus the period in which the man is infective to mosquitoes. If however, the carrier did convey

mosquitoes, the danger would last as long as the life of the insect.

It was this last fact which caused the perturbation amongst sanitarians on the opening of the Panama Canal, and would do so again were that filter of shipping disturbed by a war.

The insect could be carried in a closed hold, giving no warning of its presence by causing an outbreak on the voyage, and be distributed into the highly susceptible regions of the East.

Infected men alone, before they reached infectible mosquitoes would have died, or become non-infective.

Rate of dissemination of the virus.

When first introduced into an infectible community the virus spreads slowly, because of the "extrinsic incubation" period in the mosquito.

Thereafter cases contracted in the first focus will develop further afield and infect other aegypti, and in a few weeks, cause a rapid spread.

If the virus is introduced by the mosquito to a place not hitherto breeding them, the spread rate will depend on the spread rate of the insect as determined by the factors already discussed.

This is well illustrated in the epidemic of 1793 in Philadelphia, U.S.A., and described in the section on "History" Pages ××

Regions in which Yellow Fever becomes established can re-infect those regions from which they originally received their infection, but which had freed themselves from the disease, either by "failure of the human host" or winter temperature.

Thus Yellow Fever passed between the West Coast of Africa and the East Coast of South America and from island to island in the Lesser Antilles, causing many recriminations between the local authorities and giving subject for a humerous account by Moreau de Jonnés (Monographie historique et médicale de la fièvre jaune des Antilles, 1820).

Carter, (Early History of Yellow Fever, 1931) has put under the following headings the conditions favouring the occurrence and persistence of the disease.

These are both meteorological and sociological.

"Very obviously, in regions in which the temperature at all seasons is within the limits given for functional activity, given suitable breeding places - and in practice only the lower limit need be considered - the aegypti imago will be active (reproducing and feeding) the whole year round."

"In such regions the second requirement for the continuous existence of Yellow Fever - the presence of functionally active aegypti imagoes - will exist at all seasons of the year: and if the other two factors are

also present, Yellow Fever may continue during the entire year. Such a fever is said to be ENDEMIC, and such a region is said to be in the endemic zone."

"This second factor (active aegypti) will also be present at any season (the breeding places being unchanged) in proportion as temperature at that season approaches the optimum of aegypti development: and consequently - the other two factors remaining constant - Yellow Fever will increase and decrease as the temperature approaches and departs from this optimum. This was seen in Havana, Rio, Vera Cruz, and other places in which the fall of temperature was not sufficient entirely to prevent aegypti activity at any time, but did limit it during the colder season. The conditions of temperature affect the factor of aegypti activity in other ways, in none of which it is compatible with the ENDEMICITY of Yellow Fever, that is, continuance of the infection from year to year without re-introduction, and yet with any of which Yellow Fever may and does occur."

(1) "The seasonal fall of temperature may be sufficient to suspend the activity of the imagoes for some considerable time - generally by destroying them - but is not sufficient to destroy the eggs.

(2) "The temperature during the cold season may fall so low

and remain low so long as to destroy the viability of the eggs of the aegypti."

(3) "The conditions of temperature may be such that when aegypti are introduced they cannot propagate."

(4) "Aegypti may be active aboard ship in the harbours of ports, the temperature of which ashore are well outside of the feeding limits of that insect."

"Naturally, places under the temperature conditions of (3) or (4) are always "non-infectible territory. Those under (2) are uninfectible also, until aegypti are introduced and have become sufficiantly abundant to propagate Yellow Fever, as are those under (1) during the winter."

From the foregoing discussion we can now define the terms Endemic and Epidemic, with reference to areas in which Yellow Fever can occur, and the sociological factors involved.

Endemic.

In endemic areas, Yellow Fever is not controlled by seasonal differences of climate, the aegypti being present sufficiently numerous and functionally active during the entire year.

Once established, and without any control, it will remain, depending entirely on the presence of susceptible men.

If the supply of susceptible men gives out, the area becomes free of the disease, being known as a temporary endemic area, from failure of the human host. This phenomenon frequently occurred in the Antilles, and some South and Central American areas and cities, although there are abundant aegypti at all seasons.

If, on the other hand, the supply of susceptibles is constant, so also will be the disease, which will be present, with varying incidence, all the year. This is called a permanent endemic area.

Such areas we find were Havana, Rio, and regionally endemic areas as the interior towns and villages of the States of Bahia, Pernambuco, Parahyba and Ceara, in Brazil, (Jameson-Carr,Unpub.Report,Rock,Found. March 23rd,1925).

Epidemic.

Epidemic areas are of two types (1) where the mosquito lives through the winter in the egg stage, and (2) where it is killed.

In the first type, the area is always possibly infectible during the summer; in the second, only when mosquitoes are introduced.

As examples of the first, we have the Gulf States of North America, and of the second, the Northern States of the same country, and the Northern Coast of the Mediterranian.

There are some border-line areas depending on the

degree of coldness in different years.

According to this definition, the difference between epidemic and endemic areas is due to the biology of the mosquito, and that between permanent endemic areas and temporary endemic areas is due to a sociological factor, i.e. the supply of susceptible humans.

This difference in definition of endemicity from the usual one used in the epidemiology of other diseases, to wit, permanent and temporary, is of great importance in planning a campaign of control.

Permanent and temporary endemicity are influenced greatly by local and national customs of those areas.

In my reports on the flow of the disease in Brazil (Jameson-Carr, Unpub.Reports, March 1925, August 1926, Rock. Found.) I showed the religious (carnival), military (revolution) and labour (coffee pickers) movements to be of paramount importance in the epidemiology of the disease.

Studying the mortality returns in Parahyba do Norte, Brazil, I could get no information of any value owing to their perfunctory character, therefore I made a search into the records of deaths amongst British subjects in that town as far back as they had been kept, and found that the majority had died during the first three months in any year, and of those months, most in March. As diagnosis was not given,

the crude death rate was all that indicated that there had been a distinct rise every year.

A further search was made in the same records of seven other towns on the coast, from Santos in the south to Ceara in the north, and all gave the same indication.

All these towns were in the endemic zone and had a high index of aegypti breeding when uncontrolled. They differed in rainfall and extremes of temperature, but all showed the rise during the first three months with the apex in March.

A record of diagnosed Yellow Fever admitted to the Strangers Hospital in Rio de Janeiro since its opening had the same curve (foreigners only) as the crude death rate in the city. The entomological factor was common to the zone, thermal and fluvial variants were similar, what then was the other factor? I quote from the March 1925 Report:-

"During the first three months of the year, in all these catholic states, there is a general movement of the people of the Interior, due to religious festivals, but by far the greatest movement is in the latter part of February and the first week of March because of Carnival. At this time, it is the custom of all who can afford it, to make for the large cities, where it is well known every hotel and pensao is booked long ahead. Again it must be remembered that travel in

this country is determined by the rains, and the year-end is the period of best roads, while September is the worst. Thereafter there is a general exodus back to the country."

"Also, business travellers at this time take advantage of the people being more ready to spend and being in greater numbers in one place, and these travellers are usually non-immune foreigners."

At the time of writing the above the large towns were under control but not the smaller towns and villages in the hinterland, and it was in those areas of regional endemicity that the disease was being revealed.

Again I quote from my Report of July 1926.

"Owing to the recurrence of the revolution in the Interior, troop movements have extended to include the entire region controlled by the Sao Francisco River, from the sea to the town of Pira-Pora, which is the terminus of river transportation in the State of Minas Geraes, and only good fortune can prevent the disease being carried into regions where no previous history has been elicited. During June, the department of Public Health in Rio reported cases in Pira-Pora, whether amongst troops or civilians was not stated, and this is important, because of the meteorology of the moment and the altitude, which has a marked effect on the propa-

gation of Yellow Fever, Pira-Pora standing 480 metres above sea level. The population flow on this river is a factor of epidemiological importance, as it is seasonal, and consists of coffee-pickers from the towns along the Sao Francisco in Bahia and Minas, proceeding to the State of Sao Paulo for work. This exodus begins in March which is the month of highest Yellow Fever incidence in Brazil."

This observation, made in 1926 was justified by the outbreak of 1928-29 in Rio, which city had not been known to have had a single case since 1908. No effort was made to prevent a spread from Pira-Pora in Minas Geraes towards the Federal District and Capital, and Soper (Distribution of Immunity to Yellow Fever, 1937) states: -

"Cases were diagnosed however, almost immediately following the discovery of the disease in the neighbouring Federal District, City of Rio de Janeiro, in May 1928, and during the succeeding three years Yellow Fever was found at more than two score points in this small state."

These sociological factors have been dealt with in detail because in the East generally, there is a parallel movement, religious, military and labour.

At the beginning of this section there was mentioned that a new era had begun in our knowledge of Yellow Fever, after

Stokes, Bauer and Hudson in 1927 proved that certain monkeys were susceptible to the disease, and that it was caused by a filterable and ultra-microscopic virus.

That this proof should have been so long delayed is the more remarkable seeing that Balfour (The Wild Monkey as a reservoir for the virus of Yellow Fever, Lancet, 1914) had stated that in his investigations in the Island of Trinidad, B.W.I., the older negroes had told him that it was a tradition among them that an epidemic of the disease amongst humans was always preceded by an epizootic amongst the Red Howler Monkeys in the forests.

Between 1923 and 1926 the writer repeatedly suggested to the heads of the Yellow Fever Commission, both in Brazil and New York, of the International Health Board of the Rockefeller Foundation, that this tradition should be followed up scientifically by their laboratory staff to the end of, perhaps explaining, sporadic outbreaks in the Interior of Brazil which were puzzling the Commission.

The neglect to do this was because the campaign at that time was being conducted on the assumption of the correctness of the Noguchi Theory of "Leptospira Icteroides" as the cause of the disease. I summed up this attitude in a letter to the "Straits Times" of Singapore, August 15th, 1936, as follows: -

"I would here suggest a warning. There is distinct danger in terms of disease control of a scientific national monopoly."

"The American Army Medical Service, and later, the International Health Board of the Rockefeller Foundation have had such a monopoly of the Yellow Fever situation in investigation and control, that for years, any statement by one of their Staff was taken as beyond question. It took failure in Brazil and Africa in the attempt to control, and death in its investigation, to show this inherent danger."

I have mentioned before that the impetus given by the findings in 1927 has caused an immense amount of research, so much so that in the "Epidemiological Report" No.R.E.179, of the "Health Section of the League of Nations" on Yellow Fever, 598 scientific papers are listed in quotation, as between 1929 and 1935. However, on this very point, the writer has made the following observation: -

"In examining the recent literature concerning Yellow Fever, full as it is of the great advances which have been made in the purely scientific aspects of the disease, one feels that its control has lost emphasis in the enthusiasm for the new discoveries."

"Havana and the Canal Zone were rendered safe, AND HAVE

CONTINUED SO, after the few initial weeks work done according to the findings of the "Reed Commission" thirty-five years ago, and the discovery at the same time by Carter, of the "intrinsic incubation period" in the mosquito, but that work has never been allowed to slacken."

"Nothing more is therefore necessary to eliminate the scourge than has already been demonstrated, especially that now, by the discovery of the real nature of the disease, actual protection can be given to those who may have to man the defences, and where the perplexing sporadic case can be definitely diagnosed". (Jameson-Carr, Straits Times, Aug.15th, 1936).

The New Discoveries may now be discussed.

Epidemiology before the new era of knowledge depended on observation of the occurrence of the disease in a human population highly susceptible, consisting of new-comers from non-endemic areas, and in communities where the virus had been imported from outside its usual range.

Because of the recent employment of two new methods of investigation, to wit, the mouse-protection test and viscerotomy we are enabled to extend surveys into what has been termed, "silent areas", where no clinical evidence is available, nor history of the presence of the disease on

record.

These new methods of survey have also unearthed another form of the disease itself, called "jungle yellow fever" which is found in areas where no aegypti could be discovered.

Apart from being a real menace to rural jungle populations, this form constitutes a permanent reservoir of the disease from which urban districts may be infected or re-infected.

The affect of this has been well put by Soper, the discoverer, as follows: -

> "Thus the dream of an American Continent free of Yellow Fever vanishes, and what was scheduled to become the first "dodo" of infectious diseases, though deliberate human efforts at control, returns to its proper place in the public health conscience as one of the important permanent threats to the sanitary peace of the continent."
>
> (Soper. Present day methods for the study and control of Yellow Fever, Am.Jour.Trop.Med., Vol.17., No.5. Sept.1937).

The mouse protection test, by which we can make immunity distribution surveys, followed the discovery of the possibility of establishing the virus in susceptible monkeys and later, in mice.

Viscerotomy is a vast extension of the already known

pathological facts in relation to the disease as it is seen in the liver in fatal cases.

The first shows the amount of exposure to previous infection in the living, while the second determines the date of the disease at any particular place. A description of these procedures in detail will be given in another section.

Although the results of the protection test are trustworthy, in practice, they must be interpreted in terms of the local conditions, which vary.

Tested by age groups, the urban type shows when the disease was present, the sexes being equal, but in the jungle type this is so only when the whole community lives in close proximity to the unknown vector.

It is in the males that we find immunity in the jungle type as they are the sex who invite infection through having to proceed towards it in their work away from living quarters, and unless aegypti are present in the houses to become infected in their turn, the disease will not spread to those who remain at home. Viscerotomy necessarily presents difficulties as it depends on the personal skill of the examining pathologist. Only those who have had an extensive experience with negative, positive and doubtful livers should be given credence.

The method is simple, being merely a non-mutilating puncture of the liver in all those who die after ten days or

less of any illness.

Medical men are not needed in applying the procedure and the portion of the liver extracted can be sent in suitable fluid to a central examining post.

Because the lesions in the liver are so characteristic, even though the symptoms have not been so, unsuspected cases of the disease can thereby be demonstrated, and measures taken to combat it.

Soper states: -

"Viscerotomy is a valuable sentinel service pointing to spots of active infection where fatal cases are occurring. The consistently negative results in the cities and towns where anti-aegypti measures are in force have been important in showing that urban endemicity is not continuing in the face of control measures." (Soper, Study and Control of Yellow Fever, 1937.)

In 1907, Franco (Franco, Toro-Villa, Fiebre Amarilla y Fiebre Espiroquetal., Acad.Nac.Med. Bogata, 1911) observed that Yellow Fever was possibly caused by mosquitoes other than aegypti, and in Socorro, Colombia, an unexpected epidemic occurred which did not appear to be caused by an importation of the virus.

Protection tests proved that there was a large endemic area, but the essential point was that this was so in spite of the fact that there were NO AEDES aegypti to be found.

This had been shown previously by Gorgas in 1916. In March 1932 an epidemic occurred at Sao Joa de Petropolis near Victoria, Brazil, confirmed by necropsy and inoculation of susceptible monkeys.

Protection tests were made of 648 individuals with 12% positive results. In hamlets and areas without recognised cases only 5% were positive, but where cases had been diagnosed up to 19% were positive.

Only 3.6% of children under ten proved immune, showing that the disease was a field, rather than a house infection.

No Aedes aegypti could be found.

In the Colombian epidemic, the mosquito, Haemagogus equinus was thought to be the vector because of its biting habits, and the reservoir, the jungle monkeys; in Brazil two other Aedes, Scapularis and Fluviatilis were suspected because they had been proved experimentally capable of transmitting Yellow Fever in the Laboratory, and were more numerous than other mosquitoes near the houses.

The epidemic disappeared spontaneously before "failure of the human host" as shown by the protection test, and this is accounted for by the mediocrity of the insects as vectors. (Davis & Shannon, Studies on South American Yellow Fever, Jl. Exper.Med. 50.81-85., 1929).

No animal reservoir was suggested but the area has many marmosets, an animal which has been suspected. In 1934

another epidemic of Jungle Yellow Fever was studied in Matto Grosso, a state in the interior of Brazil, far from the old endemic centers on the coast.

The results were as follows: -

(1) The epidemic took place without the presence of Aedes aegypti.

(2) The identity of the disease as Yellow Fever was established by clinical observation, by autopsy, by the protection test, and by the transfer of infection from early human cases directly to white mice. The definite date of acquisition of immunity was determined in fifteen cases by the observation of negative protection test results on sera obtained before the onset of illness or early in the course of the disease followed by positive protection test results on convalescent sera.

(3) Protection test survey results suggest that the outbreak studied did not originate from immediately preceding urban outbreaks of Aedes aegypti-transmitted Yellow Fever; towns with aegypti showed negative or very low immunity rates for children. High immunity rates among Indians suggest this outbreak was probably part of Amazonian Jungle endemicity.

(4) The paucity of human population in the infected district and the scatter of cases in both time and space,

together with the isolated circumstances attending many cases, argue against men being the only vertebrate host involved.

(5) The sera from five Cebus monkeys captured for this study in known infected districts, all gave positive protection test results, indicating immunity naturally acquired in the jungle.

(6) The immunity survey of the infected area revealed more than half the cases discovered. Rural immunity rates were higher than village rates, and rural rates rose as the proximity of house to fields and jungle increased.

(7) "All available evidence points to infection occurring either in clearings next to uncleared jungle or in the jungle itself, especially during the working hours." (Burke. An epidemic of jungle yellow fever on the planalto of Matto Grosso, Brazil. Am.Jl.Trop. Med., Vol.17., No.3. May 1937.)

In his masterly Report on the Epidemiology of Yellow Fever, (Biraud. Present day problems of Yellow Fever Epidemiology. R.E.179., League of Nations., 1935) covering the new discoveries, Biraud states: -

"The campaign against the Aedes aegypti is still the chief weapon of prophyaxis, not only during epidemics, but also in normal times." and again: -

"The most effective method of preventing the spread

of Yellow Fever, as well of bringing about the decline and even the extinction of the disease, is a persevering struggle against Aedes aegypti in all infected localities, and in all urban areas and maritime, river and air ports, in infected or THREATENED areas." (italics mine).

Soper, (Soper. Present day methods for the study and control of Yellow Fever. Am.Jl.Trop.Med., Vol.17. No.5. Sept.1937) sums up the situation at present thus: -

"The use of the mouse-protection test and viscerotomy for discovering the past extent and present occurrence of both aegypti-transmitted and jungle Yellow Fever are discussed. Further studies are necessary before methods other than vaccination can be developed for the control of Jungle Yellow Fever. In the meantime anti-aegypti measures are IMPERATIVE (italics mine) for the protection of cities and towns in endemic and POSSIBLY EPIDEMIC REGIONS"(italics mine).

I can now finish this section by repeating what I said in the first page, "The philosophy of control has not changed."

CLINICAL FEATURES OF YELLOW FEVER.

In a Thesis on Yellow Fever, with special reference to its control and political significance, only a brief account need be given of its clinical features, including symptoms, pathology, diagnosis, prognosis and treatment.

Of these features, diagnosis, and especially differential diagnosis, must be stressed.

Were the disease to escape to the seeded East, and the sanitary cordon be eluded, then the responsibility of recognizing it would rest on the clinician, and most probably one who had never before seen a case.

Symptoms.

These will be enumerated as a list of symptoms and signs in a "classical" case, definite and easily recognized. From the earliest times, since the disease was noted as a separate entity, three stages have been described.

First Stage.

After an incubation period averaging five days, the fever announces itself as a chill, pronounced or mild, accompanied by malaise, headache, lumbar and joint pains, all of increasing intensity.

The temperature rises as also the pulse, but - AND

THIS IS ONE OF THE MOST IMPORTANT EARLY DIAGNOSTIC SIGNS - the temperature continues high while the pulse falls; this is the well known "Faget's sign". This sign, although not constant, is very characteristic and should make the clinician extremely suspicious.

The tongue has a central coating while the tip and edges remain red.

The gums become sore and often have a red line at the teeth.

Nausea, then vomiting, may begin early, with the stomach contents first, followed by mucus biled/ stained, and soon black specks are noticed. The urine at first highly coloured, soon shows traces of albumen, which may appear within forty-eight hours with diminished secretion.

This quick appearance of albumen is another important sign of differentiation from other diseases of like type at their beginning.

Yellow discolouration of the conjunctiva can be noticed about the third day and is often the sign of alteration in dark skinned natives or tanned whites until the end. After death the colour is marked and at the first incision of necropsy it is characteristic.

The face and upper part of the body become flushed, the eyes injected, with the "ferrety" look of the old

clinicians, and the skin dry. Some petechiae may be seen with slight bleeding from the nose and mouth (gums) and the stools dark (melaena).

The mental condition is peculiar, the patient tossing about unable to rest because of the photophobia, loin pain and headache, and showing the characteristic recalcitrant attitude of the alchoholic.

Second Stage.

This is short and most delusive. The patient both looks and feels better, and I have found one up and shaving who stated he "would be out and at work next day."

There is still nausea and some vomiting, but the epigastric pains are gone as well as those in the back and forehead, and the patient is unsteady. The temperature may have remitted with the pulse, but not always.

The first stage had been one of sudden stimulation due to invasion of the virus, the second stage is the calm indicating the profundity of the effect on the organism and the success of the attack.

Third Stage.

After a few hours all the first stage symptoms continue and increase rapidly. Headache, pains and restlessness usually passing into delirium, making it difficult to keep the patient in bed.

Vomiting is severe with larger specks of blood, which goes on to the "coffee grounds" appearance which has given the disease the name in the Americas of "Vomito Negro". In especially severe cases, the vomit is actually haemorrhagic. The expulsion from the stomach is gushing and without much effort. The early congestion becomes more marked, more petechiae with actual subcutaneous haemorrhage appear, especially in dependent parts as the scrotum, gums, nose, and even eyes may bleed.

The temperature remains constant or may rise, but the pulse becomes slower.

The jaundice extends over the whole body and the urine is yellow.

The albumen increases and suppression ensues causing mental symptoms usually followed by coma and death.

The first case I ever saw, and which I attended, was easily diagnosed by the symptoms as above, and without assistance, and strikingly confirmed by the necropsy.

It was the means of warning the Authorities that Yellow Fever was present in the locality where there had been none seen for several years.

The warning was unheeded, and an epidemic occurred four years later which required extensive measures to overcome.

Pathology.

The pathological features most constantly found in the disease are jaundice, "black vomit" or "coffee ground" material in the stomach, "box-wood" fatty change in the liver, congestion of kidney and spleen, and various haemorrhagic evidences.

In the classical case, jaundice is constant, the colour is a bright lemon. It is most marked in the skin and conjunctiva, subcutaneous tissue, fat, peritoneal and endocardial fluids, cartilages, and surface of the aorta.

Haemorrhages are also constant, it being found in the skin, epi and endocardium, renal capsule, peritoneum, pleura, lungs, bladder mucosa, adrenals, alimentary canal, and altered blood in the stomach.

Liver, pale and soft, with well-marked and characteristic fatty degeneration and necrosis.

Spleen, enlarged, firm but congested with the malpighian bodies prominent.

Kidney, congested with cortex cloudy and swollen with sometimes haemorrhages.

Heart, pale and yellowish.

The Urine always contains bile and albumen, and microscopically, granular and hyaline casts.

Microscopically, Hudson (Hudson. Amer.Jl.Path.4.395.

1928) has summarized the main features thus: -

"The most characteristic lesions are in the liver, which shows marked fatty degeneration with the finer particles in the midzone. The liver cells become markedly necrotic with a granular, acidophile form of degeneration, beginning in the midzone and extending to the central and portal veins respectively, until in some cases nearly every cell seems to be involved."

"In addition to these changes haemorrhages may be present. The spleen shows congestion, small lymph nodules, and the development of enlarged endothelial cells of the pulp, and an increase of free endothelial leucocytes."

"The kidney shows numerous acidophile necrotic cells in the tubular epithelium, and also fatty degeneration confined to that region. Congestion of the small blood vessels, especially of the glomeruli, is a common feature. The tubules contain much granular debris, and hyaline, granular and calcareous casts. The heart shows granular and fatty degeneration in the muscle fibres, especially in the neighbourhood of the nuclei."

Diagnosis.

As I have shown above, the well marked case of Yellow Fever, especially if fatal, can be diagnosed with ease. This is particularly so if the case occurs in a country which has had Yellow Fever as a scourge for years, for there the clinician is continuously on the look out.

Even in such circumstances of favourable locality, the symptoms are often so mild as to make diagnoses impossible without skilled laboratory assistance, and again, in these cases the patient is so little indisposed that the clinician never makes contact.

Children especially come under this distinction, and may rightly be described the natural reservoirs of the disease.

Boyce, (Boyce. Yellow Fever and its prevention. P.197, 1911) states: -

"It unfortunately happens that at the commencement of an outbreak the "well marked" cases are rare, while the milder types .. predominate. Therefore it becomes a matter of supreme importance to review the history of past outbreaks, and to learn from them the practical difficulties which medical men have had to contend with, in arriving at the true nature of the disease which had broken out in their midst."

As regards unrecognized cases in the 1926 epidemic

in Brazil, in a report at the beginning of the outbreak I stated: -

"I think the question of increasing virulence by passage, as in other diseases, has not been given due weight". (Jameson-Carr, Unpub.Report. Rock. Found., May 22nd, 1926.)

In the section on History, it has been shown how difficult the early clinicians found diagnosis to be,and how various the diseases were with which it was confounded.

In my own experience in Brazil there was no disease of epidemic character which, at one time or another, had not been so confounded, and even those not epidemic, such as gonorrhoea, mistaken for the pains of Yellow Fever in its arthritic complications.

As the zones of Yellow Fever and Malaria are concommitant, it follows that these diseases are commonly mistaken one for the other, especially those types of malaria called billious remittant and blackwater fever, which have several symptoms in common with severe or fatal Yellow Fever.

Infectious jaundice (Weil's Disease) when severe is clinically so similar that even with macro and microscopic evidence Noguchi failed to differentiate the two diseases.

Manson-Bahr, (Manson-Bahr, Manson's Tropical Diseases,

P.330, 1935) states: -

"The difficulties of diagnosis on clinical grounds are often great, particularly in the earlier cases of an epidemic. When several deaths, preceded by fever and black vomit have occurred within a limited area, and in quick succession, a suspicion of Yellow Fever becomes a certainty. There is no clinical feature, so far as is known, which would distinguish a mild attack of Yellow Fever from an ordinary febricula, nor any pathognomonic clinical sign that would absolutely distinguish a malarial remittent from Yellow Fever and infectious jaundice. Dengue is probably one of the most difficult diseases to differentiate from mild Yellow Fever. The facies, orbital pains, and backache are similar to those of Dengue, but the appearance of the characteristic eruption of the latter disease on the fourth day should settle the diagnosis in any doubtful isolated case. Probabilities must be weighed in diagnosis when it is based on clinical grounds alone. The only reliable guides, as between malaria and Yellow Fever are the discovery of the malaria parasite and the characteristic pigment and leucocyte variation in the one, and the determination of their absence in the other; and, when cases come to the post-mortem

table, the presence of pigment in the viscera in the former, and extensive fatty degeneration of the liver cells in the latter. Occasionally, the two diseases may co-exist."

Other diseases which must be mentioned are Rift Valley Fever in Kenya, Phlebotomus Fever in the Near East and India, mild Influenza the world over - a common mistake in Brazil - Kukuruku in Nigeria (Beeuwkes, Walcott & Kumm, Tr.Roy.Soc.Trop.Med. & Hyg., 24,429-451., 1931) an un-named disease in Columbia, (Bauer & Kerr, Bol.Ofic.San. Panamerican., 12,696-715, 1933) and Dioundé in French West Africa, (Stefanopoulo, Bull.Soc.Path.Exot., 26.560-562., 1933).

Only by failure to infect Rhesus Monkeys during the acute stage, and by the absence of immune bodies in the blood to Yellow Fever, were these diseases able to be differentiated.

Laboratory Diagnosis.

As we have described, there is no certainty in diagnosis of mild cases, and in fatal cases the liver provides either by necropsy or the viscerotome, material for examination. During the first three days of the disease, that is, if there are symptoms recognizable, inoculation of the blood of the patient into Rhesus Monkeys will reproduce the disease, and they can be examined post-

mortem after about five days, killed or natural.

No matter how mild the manifestations of the disease it can be tested by the monkey, or as is better, the mouse-protection method after recovery.

These methods will be described in another section. The point of paramount importance is early diagnosis. We know that however early, either by laboratory or clinical means, valuable time has been lost in terms of transmission to the infectible mosquito. Hindle, (Hindle. Procs. Roy. Soc.Med., Vol.27, pp.1-8, 1933) puts the matter concisely thus: -

"In connection with the transmission of Yellow Fever the period of infectivity of the blood is of considerable importance. It is commonly stated that the incubation period does not exceed six days and that the blood is infective only during the first three days of the attack. However, in two cases recorded by Low and Fairley, both had incubation periods of ten days, and it is known from observation on monkeys that the blood is infective during part of the incubation period. In monkeys the virus appears in the blood within a few hours after the inoculation, although symptoms of the disease may not appear until some days later .... The period during which the blood is infective probably varies considerably, for virus has been discovered on the fourth day after the beginning of fever. How soon the blood becomes infective

probably varies according to the dose and other conditions, but I think it would be wise to consider the blood of a patient infective at least three days before the appearance of fever."

Prognosis and Mortality.

In mild cases the disease is of short duration and convalescence to recovery rapid.

As we have seen, many cases are never diagnosed, being abortive or ambulatory. This is especially so in children, but such cases are all the more dangerous as their virus, carried by the mosquito to another person can give rise to malignancy.

Prognosis is bad when the initial symptoms are severe and the temperature remains high, in obese subjects, persons of a nervous temperament, pregnant women (who abort), in the co-existence of another disease such as malaria, in ALCOHOLICS and even those who habitually use alcohol, which in my experience is the cause of the high death rate among European men in the past, and will include women in the future, in the absence of skilled nursing and the presence of energetic but unskilled doctors who fail to realize the pathological requirements in treatment, in those who have been subjected to the blood-pressure-raising ordeal of a removal to a hospital after the first twenty-four hours,

and any other circumstance which has lowered the resistance of the patient.

The mortality varies in different epidemics and amongst different races as has already been noted.

In Africa the white rate and black rate are respectively high and low, while in the Americas both white and native Indian are equally non-immune unless in a locality long endemic; this latter would be the condition in the East.

Boyce, (Boyce. Yellow Fever and its Prevention, P.214. 1911) states: -

"The very high death rate, nearly 100%, this year, 1910, in the outbreaks of Yellow Fever in West Africa, was a matter of considerable astonishment and perplexity to observers. But on the contrary, such a high death rate was to be expected, especially in a country where medical men were on the outlook for the typical severe forms of the disease. Naturally, in any disease the mortality must be very high if the severe forms form the bulk of those diagnosed. In my opinion, this apparent high rate is a positive proof that there were many other cases of mild Yellow Fever which escaped detection. Had all cases been diagnosed, I am convinced that the rate would have been very much less.... Another factor which very materially affects the death rate in any epidemic is, whether the medical men are expecting the disease or not, whether it bursts on them as it were, or whether they are expecting it. Yellow Fever cases carefully

nursed from the onset are not so fatal as is usually supposed .... it must always be understood that until the mild forms are recognized no death rate approaches accuracy."

The same author quotes Guiteras as stating in 1910, that the rate may vary from 4% to 82%, and the average rate in 227 cases as 22.7%. In Las Animas Hospital in Havana, Boyce quotes: -

> "The death rate amongst those admitted in the first forty-eight hours was 17.7%, and in those later, 32.3%. Everything therefore depends upon careful treatment from the outset."

Treatment.

Mild cases need no treatment, the virus being neutralized by the fourth day.

If however, the disease proceeds beyond the first stage or is severe from the beginning, treatment is necessary.

A few years ago, it was hoped that immune serum would be found of use, especially if administered in the early stage before extensive damage had been inflicted on the liver and other organs.

Experiments on susceptible monkeys have been made, and the results are not encouraging.

Hindle (An Experimental study of Yellow Fever. Trans. Roy.Soc.Trop.Med. & Hyg., Vol.22., No.5., pp.205-434.,1929) states: -

"The results of our observations on Monkeys do not support the view that such treatment (immune serum) is likely to be very effective. A monkey killed on the first day of fever showed extensive necrosis of the liver, and since in human cases the virus disappears from the blood after the third day of fever, it is probable that in these patients the changes are quite as rapid as in experimental animals."

Monkeys inoculated with the virus and given serum from a highly immunized monkey immediately after the first sign of infection - a rise of temperature - showed no alteration in the course of the disease, and died, giving typical post mortem signs of Yellow Fever, in thirty-six hours.

It might be possible to administer serum to those known to have been in direct contact with the patient and who had been bitten by the same mosquitoes or mosquitoes who had bitten the patient, but human experimental animals would be needed to prove it. Expectant Treatment, with rigidly disciplined nursing, must therefore be our guide.

The main points in management are, absolute decubitus (no use of bed pan allowed, faeces passed into wool in the bed), alkaline waters, as much as can be easily imbibed

careful screening if discovered before the fourth day. From my personal experience in watching treatment in Brazil, I made for my own guidance the dictum, "If you move them, you kill them."

Of the many drugs I have seen used and which are still recommended in the text books, most, in my opinion, are useless and many dangerous, chiefly because of the annoyance to the patient.

Clearing of the alimentary tract is excellent for the comfort of the patient.

The upper end he usually does himself by vomiting, the lower end should be cleared by a warm salt water enema, but even this should be avoided unless possible at the beginning.

No food should be given until a safe end is in sight, as the stomach cannot either retain it or digest it, nor can the intestine absorb it.

In convalescence the dietary ladder must be climbed cautiously, rung by rung.

Glucose should be given in small doses, well diluted, by mouth from the beginning, but if vomiting is persistant, in a 5% solution intravenously. This is to counteract the hepatic toxin.

When the patient appears collapsed at the later stage there is a natural tendency to administer stimulants; this should be absolutely avoided. I have seen the very worst results from this practice, and cases which in my opinion

might have survived, ended fatally with copious haemorrhage.

In one case, I used Murphy's treatment and method of continuous proctoclysis when there appeared the danger of suppression, with a recovery result, but whether due to that treatment or not I cannot say. It is worth trying and does not agitate the patient.

Immunity.

Persons who have recovered from Yellow Fever have a lasting immunity. This has been known since early times, and established by the observations of doctors, settlers in the Yellow Fever Zones, and sailors.

It is the reason why the disease generally attacks only persons who have newly arrived in an endemic area.

In 1928 by the discovery that Macacus Rhesus was sensitive to the virus, there was introduced a method of diagnosing human cases, and also clearing up many doubtful points as to the possibility and mode of transmission of the disease by various species of mosquitoes and determining the virulence of different strains of virus. (Stokes, Bauer & Hudson. Jl.Amer.Med.Ass., 90. 253-354., 1928).

Similarity in symptoms and pathology of the disease in man and monkey verified the diagnosis in the latter.

These workers at that time demonstrated that a dose as small as 0.1cc. of convalescent serum protected the

monkey against inoculation of the virus, and that not only the convalescent serum but also that of persons who had suffered many years before protected against a lethal dose, wherever the origin of the disease.

Thus it became possible to identify Yellow Fever retrospectively, and make surveys over large areas both suspected and unsuspected.

Sawyer, (Sawyer. Jl.Prev.Med., 5.413-428., 1931) demonstrated by protection tests that the sera of sixty persons who had had what was called Yellow Fever between 30 and 78 years previously, were immune. This is almost conclusive evidence that immunity lasts for life. Further details of these discoveries and their application in prophylaxis will be given in another section.

ETIOLOGY AND TRANSMISSION.

Before the discovery of the infectivity of rhesus monkeys by Stokes, Bauer & Hudson in 1928, as already quoted, which opened a new era in our study and knowledge of Yellow Fever, there had been many claims from other workers as to the causal agent of the disease.

Most of these claims can be explained as the result of secondary infections or mere artifacts.

One claim however deserves special notice. Thomas, working in Para, Brazil, published, "The Results of Inoculation Experiments with Virulent Blood of Yellow Fever Cases or Bites of Infected Stegomyia Calopus, "(Trans. Soc.Trop.Med. & Hyg.1909-1910).

In this suggestive report he stated that he had succeeded in obtaining a reaction in guinea pigs four and a half to thirteen days after being bitten by infected Stegomyia. That after the reaction, the animals were immune to subsequent inoculation, and that during the illness their blood was capable of infecting Stegomyia. He also used a chimpanzee in which a reaction was obtained five days after being bitten by an infected Stegomyia. I visited Thomas in Manaos, on the Amazon, in 1925, when he discussed his findings with me, and it is interesting to

record that he showed to me correspondence which he was having with Noguchi, whose claim that Leptospira icteroides was the causal agent of Yellow Fever. He vigorously opposed. The war came, funds gave out, also health and enthusiasm, but veritas praevalebit.

Thus the causal agent can as yet, only be classed amongst the viruses, ultra-microscopic and filterable.

In 1930, another important advance was made. Theiler, (Theiler. Ann.Trop.Med. & Parasit. 24.248-272, 1930) showed that white mice were sensitive to Yellow Fever virus.

The virus can be preserved by freezing and drying in vacuo (Sellards & Hindle, Trop.Dis.Bull. 25.539, 1928).

It can resist phenol at 1:150 and mercuric chloride 1:7.500 at 30 cent. for half an hour; such conditions microbes cannot stand. (Frobisher. Amer.Jl.Hyg. 11.300-320, 1930). It is killed by heating, in serum, for ten minutes (idem). It cannot resist six hours suspension in saline solution (Bauer, Amer.Jl.Trop.Med.11.337-353, 1931).

It has been demonstrated that the virus can pass through Chamberland L.11 filters without losing its activity, (Bauer & Mahaffy. Amer.Jl.Hyg. 12.175-195, 1930).

Many experiments have been made on the subject of virus culture, and it has been shown that the pathogenic power of the virus can only be maintained over long periods by cultivation in the presence of living cells, as in tissue

culture in vitro. (Haagen & Theiler. Proc.Soc.Exper.Biol. & Med., 29.435-436, 1932).

Vaccines.

The practical outcome of the laboratory studies of Yellow Fever has been the production of vaccines for prophylaxis.

This was the more to be sought as there is no effective treatment.

The extreme virulence of monkey blood, which may have a thousand million lethal doses per cubic centimetre, made the preparation of a vaccine difficult. (Bauer. Amer.Jl. Trop.Med.11. 451-457, 1931).

Extracts of the organs of the monkey were used during the Rio epidemic of 1928-29, but did not give constant results. (Aragao, C.R.Soc.Biol. 99.1341-1343, 1928).

Several other workers produced vaccines more or less successful, but the introduction of the mouse as a laboratory animal more controlable than the monkey gave rise to a method of sero-vaccination safer in its application to man.

A suspended mixture of mouse-brain virus and convalescent serum, previously filtered, frozen and dried, was inoculated into humans.

No reaction was felt nor was virus found in their

blood twenty-four hours afterwards, while all showed in time satisfactory immunity. (Sawyer, Kitchen & Lloyd. Jl. Exper. Med. 55.945-969, 1932).

The above method, requiring 50ccs. of human convalescent serum was improved by using that of vaccinated persons, with like results. (Findlay. Bull.Off.Int.Hyg. Pub.25. 1009-1014, 1933).

Human serum is difficult to procure in such large quantities as required, as it contains only a small amount of immunisins, therefore horse immunised serum was employed, containing five times as much. (Pettit & Stefanopoulo. Bull. Off.Int.Hyg. Pub.26. 1075-1077, 1934). This last method is being used in French Equatorial Africa for systemic vaccination of all Europeans, 1933-34.

A method of using virus alone, but attenuated by a temperature of 20 C. for four, two and one days for the three inoculations, and controlled for virulence on mice, has been tried in French Africa.

The reaction, although usually slight, is enough to prevent timorous persons continuing the second and third inoculations.

In a few cases there was serious nervous reaction. By mouse-protection tests, two-thirds of the volunteers (2.164) proved immune after the first injection. (Sellards & Laigret, C.R.Acad.Sc. 194. 2175-2178, 1932).

The negative result of this method is that no one so inoculated has caught Yellow Fever, but it means that the inoculated person has virus in his blood until immunised, which constitutes a danger of the possible infection of mosquitoes if present.

Both the sero-virus and the virus methods produce immunity, but the first is more simple of application and safer epidemiologically.

The application of vaccination in control will be discussed in another section.

Animal susceptibility and possible reservoirs.

While it must be stressed that man is the animal reservoir of paramount importance, it has been shown that certain monkeys in Brazil and Columbia may be the reservoirs in Jungle Yellow Fever.

Inoculation experiments have been made on the following Orders: -

Primates	Rodentia
Chiroptera	Artiodactyla
Carnivera	Perissodactyla
Insectivora	Birds.

The results have been complicated as the reactions have been so various.

Some species are absolutely insusceptible to all forms of virus no matter how inoculated; others susceptible to all forms but mostly to certain methods of inoculation and to virus adapted to either the viscera or nervous system.

Susceptibility has been found in every degree and only a few of the findings can be referred to in relation to control.

No matter what the degree, virus has been found in the blood after inoculation - quickly if the dose is large, (0.1 gramme of brain virus) or more slowly if small, (0.000001 gramme).

The sera of completely resistant animals are not fatal to the virus, which can be proved by sero-protection tests before inoculation, and by the time of survival of the virus in the blood and organs after inoculation. (Findlay. Jl. Path. & Bact. 38.1-6, 1934).

It has been shown that in both susceptible monkeys and those which are apparently insusceptible, Maccacus rhesus and Lasiopyga callitrichus, the appearance of the virus is delayed, indicating that there is multiplication.

Virus Vectors.

Since the Reed Commission at Havana in 1900-1901 definitely incriminated Aedes aegypti as a carrier of Yellow Fever virus, the search has continued, not only concerning that insect, but many others.

For the last forty years the epidemiology and prophylaxis of the disease has been founded on our conception of insect carriers.

An extensive literature has accumulated and important advances have been made, especially on the biology of Aedes aegypti, and other Aedes.

As Aedes aegypti is by far the most important carrier, in fact the only insect of proved importance, a detailed account must be given. Epidemiologically, all strains of Aedes aegypti are of equal danger in terms of their ability to transmit Yellow Fever.

It has been shown that the aegypti of the Dutch East Indies are efficient carriers, (Dinger, Schuffner, Snijders & Swellengrebel. Nederl.Tijds.v.Geneesk., 73.3255-3257, 4378-4383, 5982-5991, 1929).

Strains from India, Java, West Africa & America were proved equal. (Hindle, Trans.Roy.Soc.Trop. Med. 22.405-430, 1929). Strains from Tunis, Java and Cuba were similar, (Pettit, Roubaud, and Stefanoupoulo, C.R. Soc.Biol. 104. 60-63, 1930) as also Batavia, Athens, Havana and Dakar. (Mathis, C.R.Soc.Biol. 115.1624-1626, 1934).

Characteristics of Aedes aegypti.

Imago or Adult.

As has been stated in the section on epidemiology, aegypti has essentially domestic instincts, due, in my opinion, to its preference for human blood.

It seeks dark cool places for resting and has a colour preference for a black background. Unless compelled, in

seeking water or a blood feed, it does not fly far from its birth place.

Experimenting on mosquitoes which have been coloured with aniline dyes, it was found that 69% were captured during the five days following their release, 66% in the house of release, and 3% in the house adjoining. (Shannon, Burke & Davis. Amer.Jl.Trop.Med. 10.145-150, 1930).

It not only selects quiet water for depositing eggs, but also quiet air.

As soon as the imago is dry it flies to cover as described above.

The male is much the weaker, and always in any lay emerges first for reasons already stated. I have seen three males being carried on the wing by one female.

The preferential breeding places and also compulsory breeding places have been fully described under epidemiology.

I have shown that the condition of the water does not determine the laying, but the sides of the container. (Jameson-Carr. Exps.No.2,3,4,5,6. Unpub.Reports. Rock.Found. 1925). The life cycle is not constant, depending on the temperature of the water in which the eggs are deposited and the food available for the larvae after hatching.

I have found that I could control the cycle at will by controlling the above factors, the limit being from seven to twenty-three days in my experiments. (Jameson-Carr

Exp.No.8. Unpub.Report.Rock.Found., 1924).

Although the female will lay above any type of water and in any kind of container as already described, awaiting chance for the eggs to be covered, the water itself may be fatal to the larvae and even the eggs. In nature, brackish water of 2% strength is thus fatal. (Jameson-Carr, Exps. No.11 and 12. Unpub.Report. Rock.Found., 1924).

If the water contains no food, the larvae will not mature beyond the first moult, being carniverous, the fittest survives as long as those that die are available. (Jameson-Carr. Exp.No.14. Unpub.Report, Rock.Found.1924).

Both larvae and pupae can survive on a dry surface for at least seven hours, and when again placed in water, proceed to maturity. (Jameson-Carr, Exp.No.15. Unpub.Report. Rock. Found., 1924).

The insect on the wing is easily recognized by its gliding movement and hardly audible buzz, and at rest by the culex angle and the long white-banded legs which are continually waving.

In my experience the female bites at all hours but most viciously just before sundown, and when I have lain on a bed within a net with twenty-five mosquitoes, they never bit except on those parts where the blood vessels were superficial, feet,hands and head.

The extremes of temperature at which the Adult insect can live have been determined. It rapidly succumbs at

0°C. At 12° to 14° it becomes torpid, at 15 C - 16 C its activity is diminished, it cannot survive above 39 C, and 28 C seems to be the optimum. (Bliss & Gill. Amer.Jl. Trop.Med. 13.583-588, 1933).

Sensitiveness to high temperature would appear to be why it prefers shade and the proximity of water containers, and as mentioned before, may be the reason why the disease has not passed through the Suez Canal.

The infected insect.

The incubation time of Yellow Fever infection in the mosquito depends on the temperature of the surrounding atmosphere. It is reduced to four days at 37 C. and reaches eighteen days at 21 C. At 10 C. to 15 C. incubation is suspended and the insect remains non-infective. Should the temperature rise again to 18 C. incubation recommences and the mosquito becomes again infective. (Davis, Brazil Med. 45.77, 1931, Amer.Jl.Hyg.16.163-176, 1932).

When infectivity is retarded - even for an unlimited period - by cold, it is not done away with, and if the temperature drops after the mosquito becomes infective, the infectiousness remains. (Hindle, Lancet, 1.451, 1930).

It has been found however, that the virulence of the infection transmitted by mosquitoes cooled for several days at 16 C. is so diminished as no longer to be fatal to

M. rhesus. (Schuffner, Dinger & Snijders, Verslag, d.K.Akad. v.Wetensch. te Amsterdam, Afd. Natuurk., 39 No.9., 1930).

Identification Characters.

Seen by low power (X 16) the head is dark, with a distinct double white median line and with white lines laterally and round the eyes; palpi black, white at the tip; proboscis black. Thorax brown, with two brilliant silvery broad lateral curved lines, which converge from in front towards the middle of the thorax, these becoming much narrower and continuing parallel to one another as far as the scutellum; in the middle there are two parallel yellowish or whitish lines running the whole length of the thorax. Scutellum very marked, owing to it being completely covered with silvery white scales. Pleura with several patches of brilliant white scales. Abdomen dark, with white band at the bases of the segments. Legs black, the femora for the most part pale beneath, in many cases with a distinct white line running from the base almost to the apex and situated on the inner surface, a white spot is also visible at the apex; tibiae black; the first and second pair of legs with two white bands on the tarsi, the hind pair with five white bands, the last joint being wholly white. Wings with the veins darkly scaled, the upper fork cell being distinctly longer than the second, and its base slightly nearer the root of the wing. Length 3.5 to 5 mm; average 4.5 mm; but very small specimens are often

met with. (Boyce. Yellow Fever and its Prevention. 276-277. 1911).

Egg.

The egg can survive refrigeration and even freezing. (Bliss & Gill. Amer.Jl.Trop.Med.13, 583-588, 1933). They will resist dry for at least six months. (Jameson-Carr, Exp.No.13. Unpub.Report, Rock.Found. 1924).

The incubation period varies from one to eight days normally, according to the temperature but after lying on the side of a container for six months, when water was added to cover them, the first larva was hatched in five minutes, showing that in the dry state development goes on inside the egg to a limit just short of fracture of the outer shell. (Jameson-Carr, Exp. No.16. Unpub.Report, Rock.Found., 1925).

Eggs are never laid before the female has had a blood meal, averaging six days after the meal and the number laid in one batch varies from four to ninety-one, and the total during life from one hundred and ninety to five hundred and fourteen. (Mhatre. Survey of Aedes in Bombay, 13., 1934).

As fertilization takes place as soon as the female emerges from the pupal case, it follows that eggs must lie latent in her body until she can find a blood feed. This period may be as long as 102 days; meanwhile, the

insect lives on fruit juices.

There is no evidence whatever that hereditary transmission of virus takes place from female to eggs.

Identification Characters.

Elongated, blackish and studded with white minute hemispherical bodies secreting a sticky fluid and surrounded by air cells. One end is sharper than the other, and it is this end that splits transversely when the larva is born. Each egg is laid separately and remains so.

Larvae.

As noted before, larvae as well as eggs can survive freezing.

It has also been seen that both temperature and food supply effect the growth of larvae, but markedly food.

The change from larva to pupa takes place at the bottom of the container where it is vulnerable to bottom feeding fish.

There are four moults between egg and pupa.

It is capable of remaining submerged for long periods, as bng as five hours has been recorded. This enables them to feed in tanks and other receptacles of great depth. (Boyce. Yellow Fever and its Prevention, 282, 1911).

The food of the larvae is various. They eat dead animal and vegetable matter with avidity, and in my own

experiments I found it convenient to use dried rabbit faeces which they attacked with ferocity. (Jameson-Carr, Exp.No.2. Unpub.Report, Rock.Found., 1924).

When first hatched, they are transparent but soon become dark on the ingestion of food.

Identification Characters.

Under low power, the siphon is seen to be one quarter the entire length of the abdomen, and two and a half times longer than the width at the base.

The larva lies almost perpendicular to the surface of the water.

Under high power, Antennae smooth, the tuft being represented by a single short hair; at the apex there is a minute but distinct second joint and a very few delicate hairs. The labial plate possesses eleven to twelve teeth on each side, and a larger terminal one. The base is also symmetrically crenulated. The thorax is rather hairy, some of the hairs arising from four distinct chitinous hooks situated two on each side of the thorax. On the eigth segment of the abdomen are the lateral combs; each of these is composed of from eight to ten serrated spines, varying in form and also in the number of serrations. The siphon or pecten spines are variable in form and number, but usually there are twelve. Immediately following there

is a triple hair. The last segment is very short, being almost rectangular, and bears a number of bifurcated hairs. The papillae are stout, and about one and a half times the length of the segment and with rounded ends. (Boyce. Yellow Fever and its Prevention, 1911).

Pupae.

The pupae are extremely active, the females being dark and larger than the males, which are yellowish. (Jameson-Carr. Unpub.Report., Rock.Found. 1924).

They can survive out of water for at least seven hours. (Jameson-Carr, Exp.No.15., Unpub.Report. Rock.Found. 1925).

The adult emerges from the pupa on the surface which, during the delay, makes them very vulnerable to top-feeding fish and other predacious insects and larvae.

There are no particular marks of identification from other mosquito pupae.

Transmission.

Until the virus nature of the infection of Yellow Fever was demonstrated, it had been thought that the only means of conveying it was by the bite of Aedes aegypti.

Leaving out the proved cases in the jungle of South America where another mosquito must be the vector, even infections contracted in the laboratory staffs were considered to have been of mosquito origin.

It has now been proved beyond question that infection can be acquired from handling infected material; either blood or other tissues of diseased man or other animal.

Two hospital cases are quoted in persons taking blood counts. (Low & Fairlay. Trop.Dis.Bull., 28. 290, 1931).

Thirty-five laboratory cases up to 1931 where there was no evidence of the method of infection except contact with tissues. (Berry & Kitchen. Trop.Dis.Bull. 29. 571).

This manner of acquiring the disease must be rare, for I have swallowed black vomit, slept in the soiled clothing of fatal cases, and done post mortems with my bare hands, thinking to teach, by my immunity, the non-contagiousness of the disease, and emphasize the mosquito vection. This was between 1923 - 1926.

The type of development in the mosquito of the virus appears very simple as it was found that by grinding up infected insects in syrup and feeding this to normal insects, the latter became infected after the usual incubation period. Thus the virus might be indefinitely preserved in the mosquito. (Marchoux & Simond. Ann.Inst.Pasteur, 20. pp. 16.104.161., 1906).

Faeces of infected insects are virulent, and the virus can be transmitted thus by way of the mucous membrane of the eye and the skin to monkeys; also, the male can be infected

by the faeces of the female, and when ground up (the male) and injected, infects.

As has been stated Before, the eggs are not infected. This seems strange as the virus invades the coelomic fluid which bathes the ovary of the mosquito, which negative fact is important epidemiologically. (Aragão & Lima, C.R.Soc.Biol. 102. 53-54, 1929).

Exact experiments have proved that reciprocal infection of aegypti was rare in nature and that in actual fact infection dies out in a colony of these mosquitoes after about four months, i.e. the maximum life time of an infected female. (Hindle, Lancet. 2. 835-842, 1930. Frobisher, Davis & Shannon. Amer.Jl.Hyg., 14. 142-146. Kerr & Hayne. Amer.Jl.Trop.Med. 12. 255-261, 1932).

The question of temperature on transmission has been discussed previously in this section. An estimate has been made of the quantity of virus contained in an infected mosquito and how much is injected at one bite. This is one hundred infective doses, or only one per cent of the total quantity contained in the body of the insect immediately after an infecting meal. The quantity is less ten days after the infecting meal than the day following, which proves that there is no development of the virus in the aegypti, and that it is only a vector.

Vectors other than Aedes Aegypti.

A knowledge of this subject has recently been greatly advanced, and we now know that other species of mosquitoes are capable of transmitting Yellow Fever. Those suspected in Jungle Yellow Fever have been discussed. Thirty-two insects have been tested by biting, in the laboratory. Thirty by injection of the body contents, twenty by both biting and injection.

The results can be classed as very efficient, efficient, inefficient, doubtful and negative.

The only one classed as "very efficient" is Aedes aegypti.

A. Luteocephalus and A. Fluviatilis are "efficient."

All other insects rank in the last three categories as above.

This research went beyond mosquitoes and included the other Diptera, Hemiptera and Siphonaptera. (Biraud. Present-day Problems of Yellow Fever Epidemiology, R.E.179. Epidemiological Report, League of Nations, 1935).

Therefore, although Aedes aegypti is the true Yellow Fever mosquito, and, in terms of control, the only one of importance, as has been amply demonstrated in the past, were other species present in large numbers, the possibility of infection being carried by them and an epidemic being maintained, could not be ruled out. This is more especially true in Africa and the East.

CONTROL AND PROPHYLAXIS.

For four hundred years, immigrants, sailors and the sanitary authorities of the Yellow Fever zone dreaded the disease, not only because of its mortality, which was the cause of tremendous economic waste in humans, but also the material loss consequent on the stringent quarantine against it in other countries.

The psychic element was profound, for the cause was a mystery, the scourge came as a visitation, and only cold weather was known definitely to stop it.

Even in the zone itself, it broke out one year, might remain for a few years, then disappear, only to return.

The "white man's grave" became an apt description for all endemic areas, and for many that were only epidemic.

With the discovery of the vector, and the brilliant success made by the American Army in Havana and Panama in control and eradication, followed in other pest areas and cities by like results, the terror abated.

I use the word abated advisedly, for on the opening of the Panama Canal, a panic almost ensued in the East at the thought of what might happen were Yellow Fever to find its way by shipping to that part of the world, which up to that

time had been free from it. (Gorgas and Hendrick, William Crawford Gorgas, His Life and Work,1924). That this has not happened is due to the fact that the Canal zone has been in the hands of experts from the beginning and rigid quarantine regulations carried out on shipping when necessary. It must also be noted that since 1914, when the Canal was opened, the wooden sailing ship has been almost entirely superseded by metal ships whose water was not exposed to breeding female mosquitoes, and whose length of voyage was against the disease landing in man.

Hardly had that danger been averted and the panic died down, when another arose as a result of travel by air, and that, not so much as to the possibility of infection arriving from the Americas, as from Africa.

The former panic had given rise to an enthusiasm in the East for anti-larval work which I regret to state has not continued.

In 1927 I was allowed to make a cursory survey of the aegypti conditions in Bombay and wrote to the local paper because of an article which had appeared in it on December 30th, 1926 as follows: -

"Were there no malaria in Bombay, the mosquito pest in itself is a stain on the escutcheon of any modern city. Bombay with its daily and nightly tortures is spoken of wherever travellers meet. I was astounded

to experience, and disappointed to observe, that this reputation was warranted, even though the season is a slack one in terms of mosquitoes, and on making enquiry why it should be so, in spite of the city's pretension to modernity and its evident wealth, easily got at the truth. It is sufficient to say that the reason can be left to the civic conscience and civic pride of the city fathers, and others sharing the responsibility". (Jameson-Carr. "The Times of India". January 15th, 1927).

After much discussion amongst various authorities, (six years): -

"The Government of India would be glad to be informed whether the local Government would be able to undertake at an early date, a Stegomyia survey of the major ports in the Bombay Presidency, with a view to assessing their vulnerability to the introduction of Yellow Fever infection".

This survey was accordingly commenced in the beginning of August 1933, and completed on the 31st of March, 1934. The comment of the officer in charge of the survey was: -

"The history of the events recorded above shows that Bombay, and incidently the whole country is in exactly the same unprotected state against the disease to-day, as it was a quarter of a century ago."

"The Malarial Branch of the Public Health Department has not been merely doing, as its name implies, anti-malarial work, but does anti-mosquito work in general, although it devotes more attention to the control of the malarial vector in particular." (Mhatre. A Survey of Aedes Mosquitoes in Bombay and Measures suggested for their Control, 1934).

I mention these matters to show that the Eastern Ports are potential Yellow Fever endemic centres, that the authorities are either not interested or hard to move; that where malaria is an ever present and thoroughly understandable menace, it is natural that Yellow Fever and its possibility of entrance from a great distance is not appreciated outside medical circles, and that this being so and the means of control being ultimately in the hands of government and business, some influence more powerful than local authority and more rapid in execution must be envisaged if the East is to be protected.

We may now consider what has been done to prevent Yellow Fever spreading.

The International Sanitary Convention of 1926 formulated stringent regulations to control ships coming from infected ports and going to uninfected ports where there were Aedes aegypti. In Articles 35 to 40 of the Convention, ships which were infected (a case on departure or during the

voyage) were compelled to moor not less than 200 metres from inhabited land; patients must be landed and placed under proofed nets; other persons landed must be under observation for six days after, and all mosquitoes destroyed on board.

Suspected ships, which were designated as those coming from an infected port, or a port in commercial contact with an infected port, if the voyage had been less than six days and there was a possibility of aegypti being on board, must also conform to the regulation.

All health officers and ships' doctors must have the text of the Convention in their possession.

At the time of formulating these regulations all our standard knowledge on transmission was incorporated, the three to four days of infectiousness in the patient, an incubation period of six days, domestic habits of the insect and the persistence of the infection during the life time of the insect.

Since the date of the Convention we have added vastly to our knowledge, but it is apt here to quote a statement made by Aristides Agramonte of Havana at the Jamaica Conference of 1924: -

"After the disease has been stamped out in a given locality, one must depend for its permanent exclusion, upon quarantine; this cannot be relaxed unless the

country or regions of the country from which the infection might be reintroduced are kept upon strict surveillance, or their authorities have given proof of honest notification of cases, so that confidence may be placed on their reports. This measure of quarantine, based upon a six day period of incubation, has already been demonstrated as absolutely reliable; the Panama Canal Zone, New Orleans, and other southern ports of the United States, and all the Cuban ports are good examples of the value of quarantine against Yellow Fever invasion. I would warn sanitarians to be wary of attempts to estimate the period of incubation as of longer duration, based upon results obtained by experiments on animals. In conclusion, I beg to recommend that we do not swerve from the path heretofore followed by the pioneers in Yellow Fever prophylaxis, unless it be to introduce such measures as may be necessary to meet peculiar conditions of the country, and that only, if they in no way weaken the fundamental structure of anti-mosquito campaigns." (Agramonte, Internat.Confer.Health. Probs.Trop.Amer. pp.207-208, 1924).

Honest notification comes under the subject of the politics of Yellow Fever and will be discussed later.

Except in the East, where small wooden ships still do

a large part of coastal traffic, the menace of the transport of Yellow Fever, either in man or mosquito, has largely gone. This of course depending on the care of the authorities of ports and ships to apply the regulations strictly. If Yellow Fever were to infect the East Coast of Africa, the old danger from wooden vessels breeding aegypti would return, and menace India.

The great increase and range, as well as the rapidity of aerial travel during recent years have made it urgent to revise and add to the regulations of prophylaxis. This has proceeded, pari passu, with our increased knowledge of the range of Yellow Fever as revealed by protection test, and the possibility that other reservoirs than man, and other vectors than aegypti, are in existence.

Many articles have appeared dealing with the subject, and even Italian and French writers have suggested the possibility of the disease being reintroduced into Europe. (Reitano. Giorn.di Med.Mil. 79. 539-543. 1931, and Moulinier. Jl.Med. de Bordeaux. 110. 251-253, 1933).

The most serious apprehension has been caused in the countries of the East and with ample justification.

In the Dutch Indies this has been dealt with by various writers. (Snilders. Trans. 8th Congr. Far-East. Ass. Trop.Med. Bangkok. 1. 133-150, 1930. Dinger, Gen.

Tijds.v.Nedrl.Indie. 72. 1331-1336., 1932. and De Vogel, Bull.Off.Int.Hyg.Pub. 27. 1324-1331, 1935).

By far the most complete research has been done in British India and a full set of suggested regulations to govern the situation is given by Sinton, (Health Bulletin No. 20., 1934). The African question has been discussed in reference to Tanganyika, (Scott. East African med.Jl. 9. 283-293, 1933).

In America the danger has been definitely admitted, (Cumming. U.S. Pub.Health Report, 46. 2361-2366, 1931. and Griffiths. Bull.Off.Int.Publ. 24. 948-952, 1932), while there was much discussion at the Pan-American Sanitary Conference on the whole subject, in 1934.

The transportation of persons in the incubation stage and those having the disease in the very mild ambulant stage, is a danger which does not require emphasis, but the question of the mosquito in the aeroplane, whether infected or not, has needed some investigation. We have had evidence in Natal, Brazil, that A.Gambia can be carried across the Atlantic Ocean from Dakar, French Africa, with fatal effects. (Shannon. Amer.Jl.Hyg. XV. 3 pp. 634-663, 1932). In the Americas, various types of planes were used to convey aegypti, which were first coloured for identification.

A series of 102 observations were made, from San Juan, Puerto Rico, to Miami, Florida, U.S.A.- 1,250 miles - a fifth of the mosquitoes survived after one day's flight with several stops. Between Central America and the United States, experiments on twelve planes of three different lines resulted in 8% of the aegypti reaching the termini, some after thirty hours, others after seventy-eight hours, and ten in between landings, including three all-night stops. In the Belgian Congo and Kenya, similar results have been obtained. (T.H. and J.J. Griffiths, U.S.Pub.Health Rep. 46. 2775-2782, and Bull.Off.Int.Hyg.Publ. 24. 948-952, 1931 and 1932; McMullen. Bull.Off.Int.Hyg.Publ. 25. 1024-1027, 1933; Trolli. Bull.Off.Int.Hyg.Publ. 24. 603-612, 1933; Symes. Bull.Off.Int.Hyg.Publ. 26. 1048-1056, 1934). In these experiments many types of aeroplanes were used and the authors came to the conclusion that mosquitoes could be transported, therefore infected mosquitoes might be, and that they could bite persons en route because the experimental insects did so.

It must however be remembered that because flying fields are usually well away from the centres of human habitation and that during the resting period of the planes there is seldom either the attraction of water for deposition of eggs, or humans for a blood feed, remaining in the plane, so the possibility of an aegypti seeking

such a resting place is remote.

In any case, control of aerodromes is an easy matter in terms of anti-aegypti work.

One danger must be mentioned. In my observation of flying fields and aerodromes in Malaya, I found A. albopictus in quantity, and they are incriminated as carriers of both Dengue and Yellow Fever experimentally, and classed as "inefficient". Their breeding habits are very similar to A.aegypti but their resting places, after biting, are not in houses but in the jungle. It would be impossible to control them as we can aegypti.

Finally we may say fairly definitely, that although there is a possibility of the virus being conveyed by mosquitoes in aeroplanes, the probability is that it would be conveyed in humans. As it is the British Empire on which the greatest responsibility rests for the prevention of the spread of Yellow Fever to the East, the situation in India may be taken as an example.

This situation is fraught with danger from three separate angles: -

(a) The insect vector.

(b) Human population.

(c) Simian population.

Sinton has summed the matter up thus: -

"The evidence available goes to prove that there are present in India large and widely spread numbers, not only of the most dangerous carrier of Yellow Fever, Aedes aegypti, but also of several potential carriers. While the latter may not from their habits appear so dangerous to man as is Aedes aegypti, yet there seems little reason to doubt that they would be capable of transmitting the disease from man to man, should occasion arise. The chief danger from such mosquitoes, more particularly from the jungle-haunting species, appears to be that they may spread the disease to monkeys. Such an occurrence would give rise to a very dangerous potential reservoir of the disease, which it might be almost impossible to stamp out."

Again: -

"As there is no evidence that Yellow Fever has invaded India for many centuries, there is no reason to suspect that the population has acquired immunity. That they have any such mass immunity, is not borne out by the results of the protection tests which have been done with the sera of people from Madras. It therefore seems probable that the population of India as a whole, have little or no immunity, either natural or acquired, against the virus of Yellow Fever, and that the

introduction of the disease would be followed by very severe consequences." (Sinton. Health Bull. No.20. Delhi. pp. 3 and 4.)

It has been proved that the two common, almost domestic monkeys of India are highly susceptible to the virus both by bite and inoculation, and that the pathology is identical with human cases. (Stokes, Bauer and Hudson. Am.Jl.Trop.Med. VIII. pp. 103-164).

Such close association with humans and, ipso facto, with aegypti, makes this factor of especial danger.

Certain African monkeys have been shown to be immune to protection test, proving that they had been infected by the virus. The virus must have been transmitted by mosquitoes of the jungle variety, and as certain Indian jungle mosquitoes are carriers, it follows that the virus could thus the more easily spread amongst Indian monkeys and so to man.

Again, while the infective period in man is the first three days, in the monkey it continues throughout the disease, thereby increasing the danger time in the simian population to infect mosquitoes. (Hinman. Ann.Entom.Soc. Amer., XXV. pp. 617 - 620).

The enormous simian population which, in some parts of India, has religious protection, would not only be a vast

source of infection, but also a reservoir of the virus, and being religiously protected, be all the more difficult to control.

Temperature, which has been discussed in a previous section, in terms of incubation in the insect, is favourable over a great part of the country and during a greater part of the year, while in many parts it is ideal. Soper in Columbia, and Stefanpoulo in Guinea, have recently shown that natural infection in monkeys is a fact.

Once the jungle mosquito had spread the disease to the jungle monkey, would it be possible to eradicate the disease?.

Again let it be stated - the disease must never reach the East.

Having shown how highly susceptible India is with its congested population of man, monkey and mosquito, we may now discuss the possible route of infection.

In the Epidemiological Report of the League of Nations, R.E. 179 of 1935, p.143, it is stated: -

"The nearest focus (to India) is in the south of the Anglo-Egyptian Sudan in the provinces of Bahr-el-Ghazal and Mongalla. This latter province is crossed by the Imperial Airways' air-mail line from the Cape to Cairo with halts at Juba (night stoppage) Malakal, Kosti and Khartoum. The journey Juba-Cairo, now performed twice

weekly, takes two days. On the other hand, Karachi is two days journey from Cairo by the direct service (twice weekly) of the Dutch Line "K.L.M." and three days from Alexandria by the Imperial Airways' line, with halts in Palestine, Iraq, Iran or Arabia.

British India, a highly infectible country, is therefore five days by air from the Yellow Fever foci of the Southern Sudan."

Since the above was written the time of flight has been shortened to $2\frac{1}{2}$ days to Karachi from Khartoum, and five days from Khartoum to Singapore or Bangkok. (Bradshaw's International Air Guide, 1938). Smaller lines and private planes communicate in all directions with these main points.

An infected man could therefore arrive at any of these infectible centres well within the incubation period and in turn infect mosquitoes before recognition of the disease could be made or prophylactic measures inaugurated.

So much for the direct method of transportation by air, which under peace conditions has been, and can be controlled by stringent regulations, but, in my opinion, would almost certainly break down in war.

The other method is slower and more insidious than air, i.e. by land from the West Coast and Centre of Africa to the East Coast, and from thence by coastal boats to India. This is the more likely method.

East Africa is highly infectible, having Aedes aegypti ubiquitous, as well as Aedes vittatus and Aedes africanus,

the two latter both possible vectors. (Scott. East Afric. Med. Jl. 9. 283-293, 1933.)

We have seen how the Americas became infected by sailing ships which in the early days were uncontrolled, and to-day the Arab dhows and other primitive craft would present the same problem.

The East Coast would quickly become an endemic area with the added difficulty of early recognition being hampered by the racial immunity of the black population.

Until the present, the long journey over high mountains for the human, and the low temperature in the crossing for the mosquito, has been an effectual barrier, but with the advent of modern means of travel, by air, rail and motor car, the stage is set for the first epidemic unless stringent regulations are enforced.

The migratory habits of the natives, who use the motor bus and lorry services freely, are an added danger.

Segregation of areas of sleeping sickness in the campaign against that disease have taught the sanitarians how difficult it is to control the migrating negro.

In 1929 the Advisory Council of the East Bureau of the League of Nations Health Organization discussed the measures to be adopted to prevent the importation of the virus to the East, the most urgent being - (a) the interdiction of all air traffic from infected or even

suspected areas to any of the countries in the regional area of the Eastern Bureau until such times as the measures concerted by the Office international d'Hygiene publique are being effectually applied; (b) The prohibition by law under severe penalty of the importation or possession of Yellow Fever virus for any purpose in all countries in the East liable to infection with this virus.

This included India, Ceylon, Siam, Philippine Islands, Netherlands Indies and Belgian Congo.

This was reiterated in 1930 by the Congress of the Far-Eastern Association of Tropical Medicine at Bangkok.

In 1929, the Permanent Committee of the Office international d'Hygiene publique had drafted regulations for the sanitary control of aerial navigation.

FOR THREE LONG YEARS THIS WAS UNDER DISCUSSION WITH THE VARIOUS COMMITTEES AND GOVERNMENTS CONCERNED.

It was finally signed at the Hague on April 12th, 1933, BUT DID NOT COME INTO FORCE UNTIL AUGUST 1st, 1935.

Thus is seen the difficulty of procuring agreement among nations regarding the formulation of initial regulations of advantage to them all commercially, but of how much greater difficulty is their honest application. Compared with previous sanitary conventions, this last took into consideration the new knowledge of the disease, especially the fact that typical cases are only a small percentage of

the existing disease.

Provision was made for means to be used to identify hidden cases by biological tests such as sero-protection and animal inoculation, with notification of the results. (Arts. 36. 37.)

Specially severe measures were taken to prevent importation of the virus into infectible areas.

In endemic areas, where the disease could be either clinically or biologically identified all aerodromes must be "anti-amaryl" which meant a competent medical staff, all necessary sanitary equipment and housing as in ordinary "sanitary" aerodromes, but in addition, special dwellings and water supply for the local staff, crews and passengers, rendered mosquito-proof. (Art. 38).

Aerodromes may be "separate local areas" and communication suspended with other localities if autochthonous Yellow Fever appeared. (Art. 41).

In contradistinction to previous Conventions, notice was taken of the importance of controlling <u>departures</u>, as well as arrivals.

(a) Inspection and, if necessary, disinsectisation of aircraft.

(b) Medical inspection of passengers and crew; suspected persons to remain under observation until six days have elapsed since the last day on which they were exposed to infection, "observation" meaning isolation in a

mosquito -proof house at the aerodrome itself.

(c) The names of passengers and crew to be entered in the journey log-book, together with relevant information with regard to their exposure to infection, and the period and conditions of the observation undergone before departure. (Art. 42).

Before the above rules were made, the infectible country had to take measures against the infection arriving, now the infected country must also take measures against a possibly infected departure.

Countries where the disease does not exist but which are infectible by reason of mosquitoes which are carriers, need not have anti-amaryl aerodromes, but are authorized to take all necessary precautions to protect themselves, including observation of suspected arrivals for six days. (Art. 47).

Where all the regulations have been carried out at the point of departure, even from an infected country, unless under very special circumstances, aeroplanes shall not be prohibited from landing, but may be ordered to some parcitular sanitary aerodrome. (Art. 48).

In uninfectible countries, only inspection, disinsectisation and medical examination of passengers may take place, but no "observation".

These are obviously excellent regulations ON PAPER, but it is the spirit not the letter which is important.

All depends on the honesty and competence of the medical

officer at the port of departure from an infected country.

With the best intention and skill it will not be simple to decide whether there has been exposure to infection within the previous six days, owing to the very various manifestations of the disease.

Apart from the typical case, Article 36. demands recognition of the form which "might be revealed by biological examination".

This involves two procedures: -

(1) Inoculation of M. rhesus, which would only confirm a suspected case, and which requires all the apparatus of a first class laboratory.

(2) Positive sero-protection test, which would only be of value had it been done recently, and in very young children.

Even thus, either a positive or negative test could only imply that the disease had, or had not, been present but might have died out.

To enforce such a stringent and severe measure as Article 42.b. (vide page 157) on a positive sero-protection test alone, would be unwarranted, therefore it should be strengthened by consideration of the presence of high morbidity among natives, and a high aegypti index.

The region of the aerodrome should be regularly tested by sero-protection, clinical and viscerotomic observation

emphasized and anti-mosquito measures rigorously enforced.

It is gratifying to record that these regulations have been tested by application in the case of Yellow Fever reported in June 1934 at Wau, in the Anglo-Egyptian Sudan.

The Government closed the Province of Bahr-el-Ghazal to all kinds of air traffic, and carried out every Convention regulation at the aerodromes at Juba, Malakal and Khartoum.

All passengers from Bahr-el-Ghazal were under "observation" for six days before embarking at the first two aerodromes mentioned above, which had been made "Anti-amyral" for the occasion.

Thus was the spirit as well as the letter of the Convention carried out.

Since the signing of the 1935 Convention, two other methods not included at that date, have been proved. Disinsectisation during flight, and anti-amyral vaccination. The first had been provided for on departure and on arrival, but it is obvious that it must be more efficacious AFTER the plane has started when no more insects can enter.

The latest test, carried out in an Imperial Airways Transcontinental Plan with an aqueous solution of pyrethin, caused the death of 50 mosquitoes in 15 minutes, and without any inconvenience to the passengers.

We have stated before that the danger of mosquito carriage is possible but not probable.

The great danger is the carriage of the man during the incubation period.

It follows therefore, that the staff and crews of a service should have vaccination as a pre-requisite to employment, and this would obviate "observation", at least of them, when passengers had to be so controlled.

As a mass practice, vaccination holds out one of the best methods of control. In countries like Africa where there is a mixed population of whites who are highly sensitive, and Negros who have both a racial and specific immunity, the whites could all be vaccinated and, as they are the travelling part of the community, a large measure of safety would be established.

This has been carried out on an extensive scale in French Africa and in some of the colonies in British Africa.

To vaccinate the natives is much more difficult, but it could be done to those who are the more mobile, such as railwaymen, motor drivers, post office officials, chauffeurs and soldiers.

In the Americas, which are included in infectible areas, the problem is different.

In the West Indies, the major population is negro, and therefore potentially like Africa, on the mainland, the White-Indian population is equally sensitive.

At least the administrative members of the areas could

be vaccinated, as has already been done to the Medical Staffs, and all mobile services.

In the areas of jungle Yellow Fever, until the vector and reservoir have been demonstrated beyond doubt, the only available method of prophylaxis is mass vaccination.

This is now being done in certain areas in Brazil, but the results await publication.

This we do know. The sera of vaccinated persons until now have all been protective to mice, and there has been no case of Yellow Fever recorded in those who, being vaccinated, have been exposed, either in endemic areas or the laboratory.

The sanitary regulations embodied in the Convention of 1912, 1926 and 1933, are all dependent on the honesty and ability of the various authorities and their staffs, in their application. The measures to be taken to prevent the spread by sea and air are relatively simple, but by no means fool-proof, and can never be without eradication of the most easily attacked link in the chain of disease, i.e. the mosquito.

This has been brilliantly demonstrated many times in South, Central and North America. When we come to consider how to protect land frontiers we are confronted with a much more complicated problem.

Ships and aeroplanes can be compelled to follow routes

and make ports and landings where they are subject to proper inspection and control, but no specific nor general rules can be laid down as regards land-to-land frontiers.

Migrating natives, caravans, hunting parties, and many other conditions which readily suggest themselves, not only in savage and semi-civilized countries, but in civilized communities, would entail administrative expense impossible to realize.

With the complexity of nationalism at various frontiers, only some special bilateral arrangement might prove effective between the actual adjacent administrations.

There is only one way, and that a proved way, in which to render susceptible areas or towns safe against the introduction of infection, and that is, to maintain the Aedes aegypti index below the critical point.

In the first part of this section emphasis has been given to the measured adopted to prevent the importation of Yellow Fever to areas in the world which, up to the present, have not been infected but which are infectible.

The same measures are applicable to those areas in the endemic region which, although free from Yellow Fever at the moment, may at any time again become infected.

Actually there are many such areas in the endemic region, and they should be all the more interested in measures which would prevent the return of conditions of which they have had

tragic experience.

That this intelligent conception of self-preservation has often been neglected was best seen in the return of Yellow Fever to Rio de Janeiro in 1928-29, after an absence of twenty years, and in spite of ample warning that it was at its gates in 1926. (Jameson-Carr. Unpub.Report. Rock. Found. August, 1926).

Unless an epidemic is present in some other part of the endemic region, it has been found impracticable to insist on the application of all the measures in the various Conventions as concerning arrivals in any particular area free from infection, but complete safety is assured in such an area if anti-aegypti prophylaxis has been persistently maintained. It was the neglect of this simple precaution in Rio de Janeiro which allowed the spread of the disease when it arrived, at resultant panic-cost to re-establish control and reputation. The fundamental principles in a consideration of the methods to be employed in an anti-yellow fever campaign were discussed and emphasized in 1932, at the Cape Town Conferences of the Health Services of the World, and again at the ninth Pan-American Sanitary Conference in 1934.

In practice it was noted that there were two aspects: -

(1) Measures of permanent application in the endemic zone.

(2) Measures of urgency, when an epidemic is discovered.

In the first, the anti-aegypti campaign stands, as ever paramount. In the second, there is merely an amplification and extension of the first.

Were the first practised continuously and vigorously in all the key points, including large and small towns, ports, river stations or other centres where humans congregate, there would seldom eventuate the need for the second, nor would it cause perturbation in the surrounding areas.

This fundamental axiom was affirmed at the Buenos Aires Conference in 1934. It would be impossible to quote from all the numerous books that have been written in great detail concerning the various experiences of, and methods employed by, sanitarians in Yellow Fever zones since the vector was discovered.

I propose to give my own experiences during the campaign in Brazil, under the International Health Board of the Rockefeller Foundation, Brazil.

The Rockefeller Yellow Fever Commission began work in Sao Salvador, the capital city of the State of Bahia, in November, 1923, at the tail end of the regular periodic epidemic.

During December, all the key cities had appointed to them a regular officer of the service who immediately instituted a campaign against Aedes aegypti in the larval state.

The idea of the Commission at that time was that if the key cities could be controlled for a certain time, they being the endemic centres, the interior would burn itself out from "failure of the human host."

That this unfortunately was not so, has been discussed in the section on Epidemiology.

Work was thus begun in nine cities on the coast of Brazil, from Belem in the North to and including, Sao Salvador in the South.

My station was Parahyba do Norte, the capital of the state of that name, half way between the terminal cities.

It is important to note that the language was

Portugese, of which I knew nothing.

The seasons in this part of Brazil are divided into the wet and the dry, and my arrival in Parahyba coincided with the middle of the dry season, or the year end.

Immediate contact was made with the Brazilian Medical Officer of Health, who had received instructions from his Government to assist the Commission in the work.

The language difficulty at once became apparent, and I decided that to prevent initial errors, no definite plan of campaign should be made, nor work begun until I had learned sufficient of the medium of communication to make myself thoroughly understood.

Meanwhile a house was selected in the centre of the city, large enough to include an office and compound for the accommodation of the staff work and apparatus.

This inclusion of house and office is important, especially at the beginning of a campaign, for the Director must be on the spot and at work many more hours than the staff.

The General Head Quarters should always be chosen as near the strategic and tactical centre as possible, as the inspectors start from the centre each morning, and return there with their reports and apparatus each night.

The first month was employed in hiring men suitable

for the work, and this is not easy.

Only healthy, morally reliable men should be employed, and especially those with normal eyesight, as an inspector has to enter houses at a time when only the women are at home, see the minute speck which is the aegypti egg, and be free from marked malformation or disease, such as skin disease, for he must deal with the drinking water of the inhabitants.

In the anxiety to lower the index at once, these points were not appreciated and were the cause of many complaints from householders, and then it was brought home the essentially domestic nature of the campaign.

Later, during an inspection of eyesight in another station where there had been reported a very consistently low index for two years under impossible meteorological conditions, it was discovered that the whole force had 68.7% under normal vision. The chief inspectors, 75% less than normal, including the director himself. The report stated: -

> "It is submitted that normal vision is of primary importance in work of our type. The age of the force varies from 17 to 66 years, and therefore, opthalmologically, no man over 40 can be blamed should he fail to see small larvae, the presbyotic condition being normal at that age, therefore each man should be examined before being appointed, this being just to the man and safe-guarding the Commission". (Jameson-Carr. Unpub.

Report. Rock.Found., Jan. 1926).

The index in this town had been given as under 1% for two years, whereas it was over 12%, thereby giving a false sense of security.

Before opening the office to hiring, a plan of the town had been acquired and an estimate made of the number of houses, average number of houses in a zone of one day's work, and the number of zones and districts.

A large blackboard was constructed, and on it the plan was painted in white, three districts marked with different coloured lines, and zones deliminated.

At the end of each day's inspection, the man in charge of a zone chalked off the block of houses he had inspected so that only a glance was needed to see how the work was progressing.

Naturally, in a larger town, more than one blackboard would be needed, as I found in Bahia, when I was transferred to that State.

In the compound, fish tanks had to be built of concrete, as in the first experiment I had used old wine barrels cut in half, which, still retaining acetic and tartaric acid, caused the death of the fish.

The placing of fish was a constant cause of friction with the inhabitants as they accused them of poisoning their water, and has since been given up.

To-day fish are only used in large tanks whose water is

not used for drinking.

A book with tear-out leaves was given to each inspector, who made entries as he went from house to house as follows: -

(1) Number of houses inspected.

(2) Total number of houses encountered with foci.

(3) Total number of water containers inspected.

(4) Total number of containers breeding mosquitoes.

(5) Total number of containers encountered with live fish.

(6) Total number of fish placed.

(7) Number of water containers sealed.

(8) Percentage of houses found with foci.

(9) Percentage of containers found with foci.

(10) Notes.

At the end of each day these reports of the inspectors were collected by the chief inspectors of the district, and the district as a whole calculated; while at the end of the week, the whole town report was completed.

Two checks daily were made on the inspectors, first by the chief inspector of the district who examined five houses immediately behind and in front of his man without telling him of the result, and by my assistant, who covered the whole town irregularly, while I myself examined at any point without notice.

A rapid means of finding an inspector was by means of

flags on small sticks with a metal point which could be stuck in the gate or in the adobe wall of a house so that it hung at an ahgle to the wall, permitting at a glance the location of the house in which an inspector was working.

By experiment, we found that the best colour for a flag was: -

Dark Red.
Black
Dark Green
Yellow
Light Blue
Pink.

We chose the Yellow, as we found that the first three were used already in the town for specific indication.

The Yellow was associated with our work and had the letters "F.A." stamped on it, (Febre Amerello). (Unpub. Report. Rock.Found. 1925, G.Jameson-Carr).

Each inspector carried with him an Identity Card to guarantee that no unauthorized person entered a house, for by this means we had already eliminated two thieves who had applied for work.

As an encouragement to good work, the "Semana Inglez" (English week of $5\frac{1}{2}$ days was introduced) no other labour in the district having this priviledge, and as a result, the work was both speeded up and better done.

The scheme of covering the whole town in one week was originated on the assumption that from egg to adult took eight days, but it was soon demonstrated by careful

experiment that the cycle in Parahyba was never less than thirteen days, and this fact led to another scheme being left with the authorities after the immediate danger was over, and the aegypti under control, and at much less cost.

This will be quoted at length at the end of this section.

It will be seen in the section on Epidemiology, Page et seq. the various types of water containers that an inspector could encounter, and the means of control were also various.

As to method, much depends on the water supply of any particular town and even particular districts and individual houses in a town.

If water was laid on, and the supply constant, there was no problem in terms of water. All the inspector had to do was to see that no water was allowed to stand in any recepticle, and if found, emptied. Outside however, he had to watch for dis-used tins, coconut shells, etc., and these were either punctured or smashed.

If the supply was intermittent or dependent on rainfall and roof collection, water had to be conserved, and fish placed.

As I have already stated, this method caused much friction with the inhabitants, but at that time was necessary as we did not have the backing of the law which now

is enforced, and if after a warning a container is found with larvae, it may be oiled, which ensures cleaning, especially if containing drinking water.

I attempted to obviate this friction by supplying cotton covers for the jars of drinking water which had a tape attached for tying round the top.

This was only partly successful, and depended on the care of the house-wife or domestic, while the children were often found using them as caps.

Tanks were sealed by paper strips and paste, and as they usually contained water for washing or gardening, could not be oiled; if they could not be closed, fish were used.

Parahyba was a town with an intermittent water supply to the better class houses, and a well or river supply to the poorer class.

This means that it was, what I term a "jar" town, and as many as 200 eighty-litre jars were found in one house, all breeding aedes aegypti.

Another common breeding place was in the "Pias" or circular earthenware channels placed around the foot of citrus trees to prevent the red cutting ant from destroying them.

The inhabitants objected to having oil used as they claimed that domestic animals might be poisoned by drinking

from them.

This objection was overcome by the subterfuge of dipping the small brush, carried for cleaning out such containers of debris, in oil before entering a garden, the fine film of the bristles of the brush being transferred to the water or left on the sides; an invisible but efficient film remaining.

The question of the texicity of oil was settled in the presence of a committee of the householders by my drinking a spoonful with no evil result, and also pouring some down the throat of my own chickens and a sheep.

The question of the use of oil in our work was made the subject of a special report covering the laboratory and the field.

Many experiments were made with different oils and combinations of oils, until the proper one was discovered, and its physical, chemical and biological properties determined on both Aedes aegypti and Culex fatigans.

From the point of view of its mechanical application, the laboratory was confirmed in the field, and also such things as the type of spray most economical, the weight which could be carried, the weight of man required to carry a tank full, and even means to reduce fatigue by adjusting the tank to the shoulders and back. (G.Jameson-Carr, Unpub.Report. Rock.Found. Feb.26th.,1925).

A useful fact was discovered that if a container of earthenware, wood or cement (the majority were these) were oiled every week for six months, sufficient oil was absorbed by the material to release a film lethal to larvae for another six months without re-oiling.

Because it was found necessary to eradicate not only Aedes but also Culex mosquitoes in order to get the goodwill of the people, who failed to distinguish between the two, oiling of drains and cess pits was undertaken.

Here I ran up against another snag, for the oil killed the aerobic organisms which reduced the cess, but happily the inhabitants did not realize that, and their freedom from Culex which were more troublesome than Aedes as biters, made the important part of the work more easy of accomplishment.

As the rifle is to the infantryman, so is an electric torch to an inspector. In the early days before torches, an inspector had to either empty a container to a small water depth in order to see larvae, or dip out the last two or three inches. That procedure took much time and labour, so that only few houses could be examined in one day.

With the advent of the torch, search was speeded up as the inspector could shine his torch into the container and see the larvae wriggling down to the bottom, and also the black eggs deposited on the sides above the water line.

At the beginning of the campaign in Brazil, all the force had been supplied with torches which cast a diffused light which, although good enough in comparison with the old method, was not strong enough to see the bottom of a tall 62 litre jar which was the usual water storage in Parahyba and elsewhere.

A very complete research was made into this question as to the best type of light, and the length of time a battery would last under average use. When it is noted that the Yellow Fever Commission used 10,000 batteries a month, any saving in this item of expenditure is of great importance.

Our final discovery was as follows. Spot light efficiency was twice as great as diffuse light, as six is to fourteen days use.

Each diffuse light cost 576 milreis per year, each spot light cost 288 milreis per year, which deducting the extra cost of the spot light, 20 milreis, gave a saving of 288 milreis per light per year.

Every battery issued was first tested by a volt metre and the voltage noted, different zones (according to numbers and type of container) was known to use up more or less voltage, therefore an inspector could not claim a new battery before it was due, which again saved much pilfering.

In Bahia, where this method was not in use, I found

thousands of batteries had been given out unnecessarily and the discarded batteries sold in the town.

Knowing the exact voltage life of a battery in relation to the amount of work required in any particular zone, made for fairness in checking up on the results of any particular inspector, who before the introduction of precise knowledge, was often unfairly critisized for not discovering larvae, by one of us checking after him with a fresh battery.

The type of torch should be the "fixed focus" variety with a specially strong switch, as these soon become unserviceable owing to the fact that they are switched on and off hundreds of times a day. (Jameson-Carr, Unpub. Report. Rock.Found. August and November, 1924).

Beginning the work in Parahyba in January, 1924, with an index of 69%, by August of the same year the index was 4%, notwithstanding that we had been through the rainy season, and had had all the difficulty of building up the organization while working.

When the low percentage figures had been reached, and maintained low for some time, it was noted that in certain zones, but more especially groups of adjacent houses, complaints were received from the inhabitants of the presence of adult mosquitoes.

At that time sleeping nets had been discarded over the whole town as unnecessary.

I, with my immediate assistant, would visit the zone or house and make a special thorough search for the missed water deposit which was breeding.

It was often a matter of long waiting and watching individual mosquitoes to find out from whence they came.

A fact had been noted that the male mosquito always remained in the immediate vicinity of the breeding place so as to catch the female before she had time to become thoroughly dry and so escape impregnation, also that males always emerged first and in greater numbers.

From these facts, a method was developed called "the converging method" to find difficult foci of breeding.

A place of maximum complaint was made the spot of convergence, and several inspectors began catching adults at the periphery of a circle whose centre was the spot.

The sex was noted in terms of percentage, and as the percentage of males increased, so one knew that the breeding place was being approached.

In this way these foci which the inspectors had missed, not unnaturally, were found, and the index still further reduced. (Jameson-Carr. Unpub.Report. Rock.Found., 1925).

This method has been used with great success throughout Brazil since that time, (Soper. Present day Methods for the Study and Control of Yellow Fever. pp. 666-668, 1937).

and so-called "Mother Foci Squads" have become a permanent feature of the campaign, and with the use of oil, backed by application of the law, it is claimed by Soper that indices are at 0% in some Brazilian cities, and those the most difficult to control.

Habitations and areas in any town where strangers congregate, either foreign or native, require special watching.

At first, while having instituted this special watch on Hotels, Boarding houses and Houses of Prostitution, we had neglected one of the most potent sources of contact, the churches.

This was a catholic country, and all classes mixed freely at all times in religious observance.

Parahyba was a bishop's diocese, with a cathedral, many churches, and a monastery, as well as a convent.

Being anxious not to antagonize such a powerful religious as well as political influence at the beginning of the campaign, the examination of their premises had been more cursory than particular, by the inspectors, who had an actual fear of finding foci in a sacred edifice.

I myself examined them and found larvae in many places, as well as in the fonts of sacred water.

Naturally, a person feeling ill, especially in the

dangerous incubation and first stage of Yellow Fever, would seek consolation in his church, meet there awaiting him an Aedes aegypti, which after twelve days would infect others at their devotions, and so on.

Mecca and Benares are well known in relation to the spread of disease.

The Bishop, who was an intelligent priest, allowed me to experiment with the view of finding some solution of the problem.

He readily admitted a thorough inspection by inspectors who were Roman Catholics, (we had some Protestants), but the question of the Holy Water presented difficulties.

However, even this was satisfactorily arranged by using a saline solution which did not interefere with the original purpose of the water.

It was found that although the insect would lay her eggs above the water line as before, neither would they hatch, nor larvae live, in a strength of 2% sodium chloride. (Jameson-Carr. Exp.No.12., Unpub.Report. Rock. Found., August, 1925).

The question as to whether Aedes would breed in other than man-made containers was important, and was made the subject of an experiment.

I had failed to find either eggs or larvae in any collection of water whose sides were of earth during my

entire stay in Brazil.

I was able, however, to force Aedes to lay, and the eggs subsequently to breed out, in an artificial mud puddle when all other deposits were unavailable.

This finding allowed us to confine our work to man-made containers while having regard to the remote possibility of forcing the insect to develop sylvan habits were all household deposits rendered unapproachable.

This is a real danger, but there are, as yet no records that it has happened. (Jameson-Carr. Unpub. Report. Rock.Found. Exp.No.6., 1925, and Carter. The Early Hist. Yellow Fever. p.12. 1931.)

After the force had been thoroughly trained and the town under effective control, experiemnts were conducted to confirm or not various statements made by other observers on the effect of control and the means of attainment.

One such was recorded in the "Tropical Diseases Bulletin" No.4. Vol.21. para. 3., 1921, where it was stated: -

> "Efforts at controlling the mosquito have hitherto met with little permanent success, though temporarily the Stegomya index of 80% can be reduced to 5% by a week's intensive work. The effectiveness of such measures suggests the advisability of instituting a 'cleaning-up' week at least once a year in every

town where cases of Yellow Fever have been known to occur within the last twenty years."

A small town on the railway some kilometres from Parahyba was selected, and the whole force employed to thoroughly clean it, in terms of Aedes, in one day.

The corrected census was 1,642 inhabitants, with 459 houses including those not occupied, which was 66.

The result of the inspection was: -

Houses inspected	393	
Houses with foci	78	19.8%
Deposits inspected	962	
Deposits breeding mosquitoes	109	11.3%
Number of fish placed	207	

All the methods used in Parahyba were employed, including oiling where possible, covering, emptying, and the obliteration of unnecessary deposits both outside and inside houses.

One week later, an exactly similar inspection was made and the result noted as follows: -

Houses inspected	393	
Houses with foci	93	23.6%
Deposits inspected	815	
Deposits breeding mosquitoes	113	13.8%
Deposits with live fish	9	

In the first inspection adults were found in 10% of the houses. In the second, only in 4%. In 50% of the deposits breeding in the first inspection, pupae were present. In the second only 4.6%, but the actual index of both houses and deposits were higher. Thus was completely disproved the contention of the statement in the Bulletin and the increase explained when the habits of the laying female adult is remembered.

On the first day all deposits were emptied regardless of the water level and the inhabitants naturally filled them up again which then covered the eggs sticking to the sides which hatched at once.

Jars which had been dry on the first inspection, but with eggs on the sides, were included, and the inhabitants took the opportunity to replenish their supply all at once, with the resultant increase in percentage.

Only a system which allowed of a complete eradication of eggs as well as larvae and adults would permit of such an optimistic result as suggested in the statement quoted, and that could seldom be applied.

The point to be noted is that aedes control needs time and that drastic methods are seldom applicable, therefore all the more should control be instituted and maintained before the disease has been introduced. (Jameson-Carr. Exp.no.19. Unpub.Report. Rock.Found.

June 15th, 1924).

After more than a year's work as described above, I had come to certain conclusions which I believed applied to the problem of Yellow Fever Control generally, and made the following report: -

The Director General. February 15th, 1925.
Yellow Fever Commission,
BRAZIL.

Sir: -

I have the honour to submit the following deductions from a study of conditions in relation to mosquito breeding and its control in the city of Parahyba do Norte, Brazil. This study has extended over fourteen months, from December 10th, 1924, to February 10th, 1925, or biologically speaking, one dry season through a wet season, a second dry season into the beginning of another wet season.

Thus a complete cycle in the life and habits of the mosquitoes of Parahyba has been observed, and the effects of control on the start of another.

At this point, I wish to make a distinction between "control" as understood in relation to the stamping out of Yellow Fever, and "control" in relation to what is possible of accomplishment by authorities who depend on their funds gained by taxes, which again depend on the variable economic situations of any year, and not least,

on the appreciation by those in power for the time being, of the advantages of control.

As regards the former, the "Commisae contre Febre Amarella" had a definite object in view, i.e. the rapid and intensive reduction of the index of Aedes aegypti, and its maintenance over such a period as would render the vection of the disease impossible, and therefore completely abolish it.

The Rockefeller Foundation at this time bore the entire expense of the campaign.

While this was the object, in order to gain the co-operation and appreciation of the inhabitants who are, in their ignorance and often even superstition, the main obstacle to a campaign in public health in all countries, the other species of mosquitoes found breeding in or in the immediate vicinity of the city, were included in the measures used, as people of the householder type do not differentiate between species, nor the diseases they convey.

In this city these other species were Aedes argyrotarsis and Culex fatigans, both vectors of disease, while a few others added their torment in a lesser degree.

As regards the latter, it has been shown, pari passu, that a city can be rendered not only safe, but comfortable so much so that it excites the envy of other cities not in a

like position, and thereby raises the "vergonha" (pride) and civic status of that city.

The urgency of the former necessity obliged the Commissae to expend funds much greater in amount, and to employ a staff of larger numbers, than would have been the case had there only been the latter expediency.

Again, in the campaign in Parahyba, early in the work, it was found necessary to separate the Commissae from the Prohylaxia Rural (Public Health Department) which department was supposed to give actual and moral support to the object, and on whom it depended for the enforcement of the regulations regarding it, and although we never had this assistance, in fact their antagonism, we have accomplished all our aims, without once appealing to the authorities.

In other words, we believe that our object would and should be better achieved by influencing the people from below upwards than from above downwards.

The result has been gratifying both from the point of view of eradication of the mosquito and the attitude of the people.

I am of the opinion that now that the danger of Yellow Fever is passed, mosquitoes per se can at least be kept under to the extent of rendering Parahyba comfortable, if not as safe as it has been during the last six months, and for a much less expenditure, compatible with the city's financial

position. This opinion has been deduced by the study of the mosquito cycle and the results of the campaign.

Our scheme has been the inspection of each habitation once a week, or twice, as the condition of a particular zone demanded, and therefore the employment of a greater number of men than necessary for an ordinary scheme, and the use of material and appliances in excess of that required, had we had the power to enforce the law. The average of such expenditure has been 15,000 dollars (milreis) a month, and the employment of up to sixty persons during the most intensive part of the campaign; but this has been much reduced latterly while retaining a satisfactory index, in terms of Yellow Fever.

The raison d'etre of the scheme of the Commission has been the cycle time of the Aedes aegypti, which was taken as eight days minimum.

We know that this cycle time varies in different climates and in different countries, having the same general climate, and also different conditions of deposition of eggs.

In our laboratory in Parahyba we have found that the minimum cycle time of Aedes aegypti is thirteen days under the most favourable of food and temperature, and in those deposits most favoured by the mosquito.

Not content with laboratory findings, we followed

these observations into the field and confirmed them. (vide previous reports).

We also found that, when once a zone had been thoroughly worked by our intensive method, and had an index which was not only what is called an "inspector's index" but a confirmed "Director's Index", that it maintained that index for at least one month after all work had stopped.

Again we believe from experience that once houses which are isolated by a wall, hedge or strip of land, are rendered free from both larvae and the eggs of Aedes aegypti, they will not become reinfected for a long period, unless water deposits are introduced which contain either larvae, or, as is more usual, eggs, of which more anon in another report.

Acting on this belief and confirming it to our satisfaction, we cut out certain zones in this city, and by recent re-survey, have proved we were justified, so much so that we have proposed a formula, "Given thorough control for a year over the entire area of a city, thereafter only the central congested sections need be worked." In other words, take care of the centre and the periphery will take care of itself.

The weakness of flight of Aedes aegypti is well known and has been used to determine the extent of isolation and

fumigation in relation to actual fever control.

As regards Culex and Anopheline mosquitoes, these points do not hold good, but in a country such as this where the dry season is of such an extent that the available deposits in and around a town are practically obliterated, much can be accomplished, especially with Culex, by a closed system of sewage, and this is being done in Parahyba, while the Commissao itself completely controlled the main source of Anophelines in the immediate vicinity of the city, (vide previous report).

Based on these facts, the plan which I propose for the city of Parahyba for the continuence of the work after the departure of the Commissao, is as follows: -

(1) The minimum cycle being thirteen days, the force shall visit each habitation once every twelve days.

(2) That the work be under the Chefe of the Department of Hygiene, not the Prophylaxia Rural (a Federal Organization), in order to give it a city status.

(3) That the City take over the work directly from the Commissao so that no day be lost in its continuence, and that they employ men trained in the ranks of the Commissao as being thoroughly trained in the work.

(4) That the force consist of: -

1 - Fiscal.
1 - Chief Inspector
5 - Inspectors.

Immediately it will be asked how it is that so small a force can take over a work, which required up to 60 men, including fishermen and oilers.

First.

The work is in such a state that the adult mosquito is reduced almost to vanishing point.

Second.

In a city scheme fish need not be employed as the force could be armed with the law, and the fines provided for in the regulations be enforced as to emptying and covering all deposits. (Art.12-63-4-5 1591 and paras. of Regs. of the Dept.Saude Publica).

Third.

All the inhabitants could be compelled to oil their own cess pits until such time as they are replaced by connections to the new drains, the type of cess pit being the reason for our large expenditure of oil.

Fourth.

Oil cans and fish buckets being unnecessary, assistant inspectors are not needed.

Fifth.

The stores and office work being small, could be included in the general arrangements of the Hygiene Department.

(5) Expenses.

This work being of a permanent nature, lower salaries

could be paid than was done by the Commissao, which was temporary, but they would have to be enough to attract both good men and prevent bribes being offered to cover the reporting of law breakers.

Chief Inspector	800	dollars	per mensem.
Inspector	400	"	" "
Assistant Inspectors, (5 at 250 dollars) 1,250		"	" "
Spot Lights. (7 at 45 dollars)	315	"	initial cost.
Batteries at 12 dollars (2 each month for 7 lights)	168	"	
	2,933	"	per mensem.
Total yearly expenditure:	33,196	"	
Subtract Spot Lights:	32,811	"	
Per Capita charge: (calculated on last census of 50,000 inhabitants).	657	"	

Comparative commodity value:
One Bottle of Beer: 2 dollars 50 cents.

The Rockefeller Foundation for twelve months 1924-25 had expended 250,000 dollars.

The expenditure of lights and batteries was arrived at according to a previous research. (Exp.No.17. of Report).

The numberof personnel was calculated as follows: -

Granted the thirteen-day cycle stands, in one day, as at present, our average visitations number 150 to each

inspector, in twelve days therefore, he could visit 1,800 habitations.

The number of habitations in Parahyba is 8,285, therefore five inspectors (asst.) could visit 9,000, thereby allowing ample margin for additional or inclusions for at least one year.

This means a split week, but I am of the opinion that as my cycle was determined in terms of the minimum, the Sunday could be included with safety and the working week kept intact.

It must be noted that many zones in Parahyba are composed entirely of "Shacks", and by many personal trials, I have confirmed the fact that they can be well worked at a rate of 80 for the first hour, and thereafter in descending numbers to 40 for the last hour, giving an average of 300 a day. This fact could be utilized in properly apportioning the correct number of houses to each man.

An excellent blackboard map of the city, with zones, districts and the number of houses in each, is available, and has been used by the Commissao.

In all such schemes the weak points must be noted, and I regret to submit that there is one which is of paramount importance. As we all know the administrative ability of the inhabitants of the tropics is below that of northern latitudes. My experience here shows that the men we employ can produce the results, but only if properly fiscalized;

in this lies the danger and weakness of my scheme.

The man of Brazil of sufficient education and personal honour to undertake such a work is not of the type who will do it, as it involves hard, sometimes dirty labour, and only those who have lived in the North and learned that all labour is honourable, have been of service to the Commissao. Such men are rare.

However, as the aim of the Rockefeller Foundation, as stated in many Reviews, is to educate the people to look after their own health problems, this has never been lost sight of, and while lowering the index, the future of Parahyba has had our attention.

I regret that I cannot put this scheme to test myself, owing to the necessities of our particular service, for although I believe no mosquito need ever reach adult life, undoubtedly the larval index would go up, but after all the safety of any town depends, not on its larval, but on its adult mosquito population.

To sum up, the question is, "find the man". (Jameson-Carr. Unpub.Report. Rock.Found. Feb.15th, 1925).

I have quoted the above report in full because of the statement made in the third paragraph of this section regarding the comparative simplicity of Yellow Fever control in terms of the mosquito alone,and the social and administrative difficulties met during an approach to the problem.

After blunders and failures due to concentration on the insect alone, I wrote out for my own benefit what I considered was the physical, mental and moral equipment of the person responsible for the direction of any scheme of Yellow Fever control.

The failure to recognize the necessity of selecting personnel with the three attributes above mentioned above, well balanced, was the cause of the discredit of the Foundation between 1923 and 1926, coupled with the lack of co-operation between Federal and State Authorities, and which gave rise to such antagonism in the public press as illustrated in the "Diario de Noticias", "The Smash-up of the Rockefeller Foundation, the Illusion concerning North American Science". (Bahia, July 1926). This lesson was quickly taken to heart, and the entire service re-organized with the well-known satisfactory results.

In my opinion, it is essential that a Director of an area should be thoroughly trained, not only in the purely scientific aspects of the disease and its control, but also in business administration.

I personally found that everything I had ever learned became, at some time, of value.

Habit of command gained in both military and naval service, for Yellow Fever is an enemy to be conquered, and needs a plan of campaign with strategy as well as tactics;

a rigid discipline, for one is often dealing with a personnel whose morale is poor and must be built up. Infinite tact and patience, for it is largely by persuasion that the people can be brought to aid themselves and you.

A wide knowledge of human beings in their domestic environment, especially women, because they are the members of the household with whom the Inspector comes in direct contact.

An understanding of mass psychology, as well as the individual, for panics are bound to occur.

An ability to learn foreign languages and an absence of Nationalism in its aggressive phase which so quickly antagonizes, no matter how erudite one may be in the particular subject.

A particular as well as general knowledge of the entomology of the mosquito, for the insect is not constant in its habits, and behaves variously in different localities.

In fact, physics, chemistry, meteorology and piscatology are all enlisted, without which the campaign will be both ineffectual and vastly wasteful.

Each phenomenon noted in the field must be brought to the laboratory and worked out, and each experiment and discovery in the laboratory proved in the field, otherwise one is open to a wrong conclusion in either a priori or a posteriori false premises.

Although a knowledge of the pathology, bacteriology and serology is not necessary in pure control, yet it will save face and increase prestige if the Director is au fait with these aspects.

The history of the disease must be studied both generally, but particularly on the spot, as well as epidemiology as a subject.

Lastly, it must be remembered that sound health is essential, for there is nothing so strenuous as the constant wear on both body and spirit which is entailed in a Yellow Fever campaign.

Excessive heat, long hours in the field or over the microscope, continual wetting by rain, sweat and swamp water, hard travel by various means from foot to aeroplane, long periods of poor food and water, constant discouragement both from your own failures and the antagonism of others, the need of never relaxing for a moment, a position gained must be held at all costs, all this makes a demand on the whole man which only a whole man can sustain.

THE POLITICS OF CONTROL.

The definition of political science is the science of the form and principles of civil government, and the extent and manner of its intervention in public and private affairs.

It is the latter part of the definition which finally concerns the control of Yellow Fever.

It must be emphasized that there has been, and I fear, always will be, a sinister as well as a dexter political influence at work wherever control has been exhibited.

As has been stated before in a previous section, we have known since 1900 all that is necessary to control Yellow Fever, and therefore we are forced to the conclusion that, it having been amply proved that the disease is extinguishable, and that it is sound politics that it should be, either scientists have been lacking in forceful exposition to the politicians, or the politicians have been deaf to the appeal.

In my own opinion, it is fair that both should take the blame.

Mass inertia and the spirit of complacency have combined with ignorance and vested interests to dull the

fair vision engendered by the spectacular success of the pioneers of control.

It is a sad fact to have to record that disaster followed by fear has been the chief stimulus to political and social recognition of the need of instituting control.

It was the fear that Yellow Fever would compel the evacuation of Cuba, where the Spanish Army had failed, which gave Reed his opportunity of research, and Wood and Gorgas their chance to demonstrate control.

Yet, having shown conclusively and spectacularly that the Yellow Fever tide had at last been turned, it required the fear of disaster and military necessity to break down the resistance of military ignorance and governmental complacency, and allow the same Gorgas to apply the same method six years later in Panama to the same military organisation of the same Government, and demonstrate the classical example of what could be done when the sciences of sanitation and politics co-operate.

It is therefore more cogent to the study of political influence to observe the sinister aspect, and under three headings - Local, National and International.

Local.

For this aspect I can do no better than give my own experience on being appointed Director of the Yellow Fever Commission in the capital and State of Parahyba do Norte,

Brazil. To fully understand the local political conditions it is necessary to quote the instructions with which I was presented and which were to guide my work.

"INSTRUCTIONS APPROVED BY THE MINISTER OF JUSTICE AND INTERNAL AFFAIRS AND SENT OUT BY THE NATIONAL DEPARTMENT OF PUBLIC HEALTH IN CONNECTION WITH THE PREVENTITIVE WORKS AGAINST YELLOW FEVER.

An agreement having been established between the Federal Government and the Rockefeller Foundation, to execute the works of the definite extinction of Yellow Fever in the States of the North and North-East of Brazil, I, herewith authorised by the Minister of Justice and Internal Affairs, send out the instructions that must be observed by the men in charge of said works: -

(1) The basis of the campaign will be the extraction of the transmitting insect in its larval state. However, in the cities where there are, just at present, still cases of yellow fever, the service of separation and observation may be maintained, <u>independent</u> and <u>completely</u> separated from the work of the campaign against foci."

Then follows a description of the personnel: -

(3) The Central Commission (Rio) will direct the prophylactic campaign and superintend the service in all the parts where the same will be

instituted.

(4) To the Chiefs of the Prophylaxia Rural (Federal) will fall the local direction in the corresponding States. They will have to fulfil, and make their subordinates fulfil, the Central Commission's decisions.

(5) The Fiscals (The Rockefeller State Director was called a Fiscal) who will be immediate assistants to the Chiefs of Prophylaxia Rural, will inspect all the time the service, and deliver weekly reports to said chiefs, to be transmitted to the Central Commission.

(6) The Fiscals are authorities to correct weak points of the service, directly or indirectly, and to call the employees' attention when necessary. They can propose to the Chiefs of the Prophylaxia Rural the penalties of suspension and dismissal of men under their orders.

(6), (7), (8), (9) and (10) describe the work to be done.

(11) The appointing and dismissal of employees under their orders will be done, in accordance with proposals of the Fiscals, by the Chiefs of the Prophylaxia Rural, or during their absence, by the Fiscals themselves.

(12) The nomination of higher staff (Fiscals, Chief Inspectors, Office Employees) will be made by the Central Commission.

(13) Any steps to be taken, which have not been foreseen in these instructions, will be taken by the Chiefs of the Prophylaxia Rural in zones where they exist, or in their absence, by the Fiscals, and communicated to the Central Commission.

(14) Other extraordinary steps found necessary, will be asked for by the Chiefs of the Prophylaxia Rural, or during their absence, by the Fiscals, to the Central Commission.

(15) The General Director of the Department will be in charge of the part in connection with the requests to the Federal Government of steps to be taken by the latter, as well as, through the Minister of Justice and Internal Affairs, communicate with the State Governments to obtain the necessary administrative facilities regarding the works.

(16) The facts of greater importance requiring the interference of the Governments Superior Authorities, will be communicated, by the Director of the Department, to the Minister of

Justice and Internal Affairs."

These general orders were followed by private instructions from the Director General of the Commission: -

(1) Our agreement is to do antilarvae work only, and in the large cities only, and not to isolate, fumigate nor do any other direct or indirect handling of cases.

(2) Naturally we want to know of cases, and they should be reported by you to the Bahia Office (Headquarters) and if it is possible, in fatal cases, to obtain tissue for Doctor Noguchi, but this must be by persuasion, as we have no right to make demands.

(3) The work is to be done under the Servicio de Prophylaxia Rural, and although the agreement gives us clearly defined right to obtain dismissals and employ personnel, it is to be done by the Chefe de Prophylaxia Rural on our recommendation.

(4) We must cultivate the goodwill of the Chief in each state, and you can pay him one conto monthly (1,000,000) for his aid in employing suitable men and obtaining popular co-operation.

(5) Endeavour to become the trusted friend and assistant of the Chief. If you can obtain that

status, all the minor differences will be easy to adjust. Convince him that you want the people to credit him with the success, and try to see to it that they do."

Although the foregoing instructions were national in their scope, they affected the local situation politically.

It must be noted that the coastal area to be worked extended from Manaos, 900 miles up the Amazon River, to the capital of Bahia, a distance of 2,600 miles, with a further 900 miles to Rio de Janeiro.

Communication was by boat, and slow, and by telegraph which was very uncertain.

As has been stated before, the idea was that were the disease controlled for a length of time in the larger towns, which were considered endemic centres, it would die out in the interior by failure of the human host.

At that time, Jungle Yellow Fever had not been discovered.

On arrival in Parahyba I found that the Chief Prophylaxia Rural had acted on the instructions by employing personnel which in his opinion were sufficient to do the work.

He had had no experience in Yellow Fever control, and the numbers were quite inadequate, and consisted of relations and friends in the best positions whether capable or not.

The squad was at once augmented, but I soon found that everyone, from the President down, was interested in having his man employed by an organization which paid much above the market price for labour.

After a month of trial, it was found impossible to carry out the primary object under such conditions, and I was driven to disband the original force and hire anew only those who were willing to work for me alone.

This naturally caused much ill feeling amongst those in authority, and a campaign of vituperation was begun against me in the Press.

I pointed out to the Chief that he was ordered to give me co-operation and was being paid for it, but as it was not forthcoming, I stopped his conto a month.

When it is remembered that the national name for Yellow Fever was "Febre Patriotica" or the disease which kills the foreigner, and that the disease was not alarming to the immune native, any interference with the domestic life of the people was bound to be resented.

I have already mentioned the use of fish and the objections to it, which in one town caused the death by shooting of one of the Inspectors.

Our principal detractors and antagonists were the upper classes, who objected to the necessary invasion of their privacy, and among them the local doctors were the

worst.

This can be appreciated as in cleaning the water and covering it, there was a marked reduction in intestinal disease, especially amongst children. This is comparable to the results in Malaya after malaria control.

In other words, we were reducing the doctors' living.

As long as Medicine is a competitive business, such antagonism must be taken into consideration, and I found it not only in Parahyba but also in Singapore, where, after I had written to the Press about the prevalence of Dengue and the apathy to it, and the danger of the presence of its vector, I was approached by a local practitioner who informed me that I was meddling in his private affairs, as Dengue was part of his income, and a very satisfactory disease, as it had a mortality of only 0.5% and a protracted convalescence.

I lay stress on the medical attitude in Brazil, as doctor and politician are almost synonomous terms in that country.

The matter of procuring post mortem material also presented a serious difficulty.

This was a Roman Catholic community, and at that stage of civilization which made it a desecration to perform a necropsy, especially by a heretic. I was

repeatedly warned not to attempt it, and when the necessity arose, when I had to exhume the body of a Catholic foreigner, I was attacked by a mob at the grave-yard, while doing the digging myself, but I got the tissues.

In spite of every obstruction, not short of an attempted assination of myself, the index was reduced below the danger percentage and kept so.

Thus it can be seen that the local political difficulties were an outcome of the national attitude, and the impossible conditions stated in the Instructions of divided control and absence of preliminary knowledge of the situation by the Rockefeller Commission.

As the object of tactics is to win battles, so the object of strategy is to place your forces in a position to do so.

The tactics employed against the very limited objective in Brazil, i.e. to clean only the main coastal cities, were sufficient to do so, but the strategy aiming at the eradication of the disease was not.

Twice, the disease was proclaimed extinct, in 1925 and again in 1926, only to be discovered in the interior.

The weakness of the strategy of divided control, with all that it involved, was laid bare.

The fact that each state was actually a law unto itself, made any Federal scheme difficult of attainment.

It was soon found that penalties could not be enforced.

In the chartered cities of India and Malaya, this also obtains.

Local pride and vested interests are serious obstacles to the sanitarian as this personally witnessed case will illustrate.

In a large city on the coast, I was present in the office of the Chief of the Prophylaxia Rural whose duty it was under the Federal Law, to issue pratique to outgoing ships. A British captain entered to obtain pratique and was given a clean paper.

When he had left, I asked the Chief why he had done so when on his wall was a graph showing the daily cases of disease in the city, including Yellow Fever and Small Pox, of which latter disease there were more than 1,000 cases marked for that day.

The Chief replied with a somewhat condescending smile, "My dear doctor, do you not understand that I am the son-in-law of the Governor?".

In a Report by the Surgeon General of the United States Public Health Service, it was stated: -

"The first essential in the suppression of an epidemic is the truth. The deadliest enemy of the state is the man guilty of intentional concealment.

"Vigilance, truth, knowledge, energy and money are the essentials in the suppression of epidemics, and of these, none is of more importance than the truth. Communities have pandered to the vicious passion of a trade element, as merciless as it is sordid and depraved, and ever ready to raise a hue and a cry against a physician who reports cholera or Yellow Fever. Feeble-spirited health authorities, timorously submitting to the dictum of unrighteous mamon, have suppressed, and do now suppress the truth; have falsified reports, and have consigned States and Nations to the ravages of unresisted pestilence, when thousands of lives might have been saved, and distant communities forewarned, have protected themselves." (Surgeon General Wyman. Suppression of Epidemics,1900).

NATIONAL.

We have seen in the review of local politics that the success of a campaign depends in the first place, on sound strategy. Strategy cannot be changed after the battle is joined. If strategy be unsound, good tactics are of small avail.

Yellow Fever knows no state boundaries, therefore it follows that all plans for its control must be national in scope, and further, international, but of which more later.

In July 1926, I was requested to write a short summary of the Yellow Fever situation in the State of Bahia, as it was there that the failure of our campaign was most evident. This was as follows: -

(1) The Rockefeller Yellow Fever Commission began work in Sao Salvador, the capital city of Bahia, in November 1923, at the tail end of the regular periodic epidemic.

(2) This epidemic had been present, not only in the city of Sao Salvador, but also in the interior of the State, especially between latitudes 12 and 14 degrees South.

(3) No cases were reported in Sao Salvador during 1924, but in the above Interior area, many were reported, and several confirmed by Dr. Noguchi and others using the Pfeiffer Test.

(4) In 1925, no cases were reported in either the City or State, but in the town and area of Franca on the Jacobina Railroad, there was an epidemic of fever which had all the clinical signs and symptoms of Yellow Fever, and which was so severe as to stop the train service to that town, and cause the Railroad authorities to appoint a special medical officer to attempt to control it. These facts were only elicited during the 1926

contd. (4) investigation. Here it must be noted that there had been no medical inspection of the Interior of the State of Bahia between October 1924, and March 1926.

(5) In 1926 diseases of an epidemic nature began to be reported in the Interior by travellers during January, called variously "Typhoid Fever", "Fever of bad character", "Fever Unknown" etc. During February 1926, the Press took it up, and on March 1st, a Mayor of a small interior city on the Rio Sao Francisco made an appeal for help to the Governor, definitely stating that he had Yellow Fever in his town. Since that date, a general epidemic was confirmed throughout the interior in that area not immunized in 1923-1924, and coinciding with the movements of non-immune troops from the Southern States of Brazil, and spread along their defence lines against the revolutionists, and has appeared in those troops returning to the City of Sao Salvador, together with civilian cases in the interior towns in that area.

(6) One permanent inhabitant of Sao Salvador, by name Dias, and known as the "Calcada Case", has been infected from those cases arriving

from the Interior, he being in direct contact with many infected troops. No secondary cases have been found or reported, notwithstanding the fact that the district in which he lived includes some of the dirtiest and most difficult zones, and a large foreign population. Dias was a barman serving the infected troops who were billeted one hundred metres away in the terminal city station serving the epidemic area.

(7) The general index for the district in which the case lived was 2.7% for the preceding week in which the infection must have occurred, and 4.2% for the zone of the patient's work and sleeping quarters, from which he had not moved during the possible incubation period. (THIS CASE WAS PROVED TO BE INFECTED WITH LEPTOSPIRO ICTEROIDES AND THEREFORE NOT YELLOW FEVER BUT ACUTE MALIGNANT WEIL'S DISEASE.)

(8) Owing to the recurrence of the revolution in the Interior, troop movements have extended to include the entire region controlled by the Sao Francisco River, from the sea to the town of Pira Pora, which is the terminus of river transportation in the State of Minas Geraes, AND ONLY GOOD FORTUNE CAN PREVENT THE DISEASE BEING CARRIED INTO REGIONS WHERE NO PREVIOUS HISTORY OF YELLOW FEVER HAD

BEEN FOUND. During June, the Department of Public Health in Rio de Janeiro reported cases in Pira Pora, whether amongst troops or civilians was not stated, and this is important because of the meteorology of the moment and the altitude, which has a marked effect on the propagation of Yellow Fever, Pira Pora standing 480 metres above sea level. The population flow on this river is a factor of epidemiological importance as it is seasonal, and consists of Coffee Pickers from the towns along the Sao Francisco and in the States of Bahia and Minas Geraes, proceeding to the State of Sao Paulo for work. This exodus begins in March, which is the month of highest Yellow Fever incidence in Brazil.

(9) Finally, 1926 has been an optimum Yellow Fever year.

(a) Natural periodical increase due for 1926.

(b) Excessive heat during the natural Yellow Fever period, December, January, February, and March.

(c) Carnival and religious movements, festas etc.

(d) Excessive rains.

(c) And lastly, that acid test of all control in Yellow Fever, the introduction into, and movement through, an infected endemic area, of large numbers of non-immune troops. (G.Jameson-Carr, Unpub.Report. Rock.Found., July, 1926.)

This Report was dubbed "Pessimistic and unwarranted", so that I felt that if the drastic change which I believed necessary in the strategy of the campaign were to be made, I should have to resign in order to speak more frankly. My last report follows: -

To the Director of the International Health Board,
Rockefeller Foundation,
61, Broadway, New York. 26th July, 1926.

Sir: -

I have the honour to submit to your notice my personal letter to you of June 16th, 1926, in which I said, "I am writing you personally now, in the hope that I shall not have to write officially and strongly". You have requested me to-day to do so, after having accepted my resignation ...

The present situation in Brazil is due to the following causes: -

(1) That no proper preliminary scientific survey was made of the many conditions governing a campaign against

Yellow Fever.

(2) That personnel was used, especially in the most important endemic centres, totally untrained in the proper appreciation of what is required for an intelligent attack on Yellow Fever.

(3) That because of such employment, vital facts were not discovered nor interest taken, and much waste of time, lives and material ensued, and antagonism created with the Brazilian Authorities.

(4) That no adequate inspection nor control was exercised by those in direct charge, and from that, false ideas and scandalous waste has followed.

(5) That statements were publicly made as to the presence or not of the disease, without means being employed to confirm them, nor honest warnings heeded, on the contrary, such warnings were flouted.

(6) That a totally unscientific and unbusinesslike atmosphere has pervaded the conduct of the campaign from the beginning.

(7) That the reports of indices in several cities have been false and in Bahia, (main endemic centre) false from the beginning, and known to be so.

(8) That this "blunder" will be repeated if the campaign is continued under the same conditions.

These reports and quotations are given to show how when

National strategy is wrong, local tactics, no matter how good are of no avail.

They also give extraordinary point to an amazing statement in a paper published in the "Transactions of the Royal Society of Tropical Medicine and Hygiene", in November, 1938.

"During 1925, only three cases of Yellow Fever were reported from all the Americas. These occurred in Northern Brazil. It is not quite certain that all three were authentic. To one who knows something of the history of Yellow Fever, this record is striking."

"However, in 1926, the movement of non-immune troops through the interior of North East Brazil resulted in a flare-up of the disease in several states. THIS OUTBREAK WAS BROUGHT UNDER CONTROL AND THE LAST HALF OF THE YEAR 1927 WAS FREE OF KNOWN CASES. But the optimism of late 1927 and early 1928 was shattered by the discovery of cases in MARCH AND APRIL in the States of Sergipe and Pernambuco. IN MAY CAME THE ENTIRELY UNEXPECTED declaration of cases in the capital city of Rio de Janiero, where the disease had not been seen during two decades following the memorable campaign of OSWALDO CRUZ." (Soper. Yellow Fever, the Present Situation, (Oct.1938) with special reference to South America. Trans. Royal Soc.Trop.Med. & Hygiene. Vol. XXXII. No.3., Nov. 1938).

One can only deduce from this statement that, either my reports were not made available to the proper authorities by the Foundation, or that they went unheeded.

At least this was accomplished, before the end of 1926 the entire personnel of the old Commission was changed, but a change of strategy was not actually introduced until the disease invaded the capital city, proving a well-known military axiom that small losses inflicted suddenly cause more perturbation than large losses over an extended period.

Dr. Soper's paper gives in detail the extensive service which is now at work in Brazil and which has produced the great advance in knowledge and technique of the control of Yellow Fever.

Vaccination has come into its own, and more than "800,000 persons have been vaccinated during the first nine months of 1938."

Thus divided control gave place to National control, penalties were enforced which was impossible under a purely foreign direction, even although the foreigners were paying all the expenses.

Brazil, although nominally a republic and democratic, is virtually a Dictatorship, and therefore could more easily enforce national law, and in war against either disease or a human enemy, dictatorship has proved its value.

INTERNATIONAL.

In January 1936, I sent a letter to the "London Times" which was acknowledged but unpublished, although it was published in "The Straits Times" on August 15th, 1936, which began as follows: -

"In this lull in the world-wide controversial storm over the power of the League of Nations to control the future well-being of the world, with military and economic potentialities emphasized, attention might be called to one section too little known and appreciated, to wit, the Health Section."

"Even if the pessimistic opinion of Mr. Lloyd George, that "as an association of nations to establish right and peace on a basis of justice it is doomed", is proved correct, perhaps a new beginning might be made on the common basis of international health."

"This has a special significance for the British Empire with its breadth of lands and diversities of peoples."

In view of recent events, this portion of my Thesis has had to be reconsidered, as I had hoped that some common ground might be found at the time of writing (1938-1939).

After attending the Anti-Malaria course conducted in Singapore by the League, and seeing the work of the Eastern

Station in that city, doubts began to arise in my mind.

This was strengthened by a visit to the Health Section in Geneva during the Spring of 1938, and forced me to the regretable conclusion that as co-operation in health matters depended on complete political co-operation, the League was a laudable but, for many years yet, a pious illusion.

Apart from the European situation and its repercussions all over the world, but especially in those parts diectly concerned in the control of Yellow Fever, the present composition of the League precludes co-operation as a whole but actually favours a much stronger co-operation between those countries which have most to gain or lose.

As I have stressed before, the war has almost certainly endangered even that hope.

Absent from the League is the United States of North America, which never joined, Japan, Germany, Italy, and ipso facto, Ethipia, Austria and Czecho-Slovakia.

In South and Central America, Brazil, Chile, Costa Rica, Guatemala, Honduras, Nicaragua, Paraguay, San Salvador and Venezuela have resigned, while Republic Spain has disappeared.

Those who remain are Great Britain and France with their colonies and the Dominions, Russia with her small protegees, the Scandinavian countries, Liberia, Turkey, and the yet

unconquered portion of China, Egypt and the countries bordering on the Indian Ocean. In April of this year, (1939) Switzerland informed the League that in the event of war it could no longer be headquarters of the organization.

Since the above was written, the course of the European War has had disastrous effects on the League of Nations. At the present moment, (August 1940) Mr. Avenol the League Secretary has resigned, and the Political Section has practically ceased to function. The International Labour Office and the Health Section will probably be transferred to New York under the direction of the Rockefeller Foundation. Thus we may dismiss the League of Nations in terms of Yellow Fever Control.

What alternative international possibilities remain?

Taking the Americas first, it is noted that at the present time they are realizing more than ever their mutual interests, and being the pioneers in control, are more aware of the benefits from it, as well as the danger from the lack of it.

Two things have recently accentuated this awareness. First, the discovery of the jungle form of the disease, and second, the scheme of building a highway through South and Central America to North America.

The difficulty of controlling foot and wheeled traffic in contradistinction to air and sea, has been noted in the

section on Epidemiology.

Even the latter has been difficult to enforce in South and Central America as during the Rio epidemic of 1929 the disease was found on ship-board all along the East Coast from Buenos Aires in the South to Manaos, 900 miles up the Amazon, in the North, a distance of 4,000 miles. (Soper. Trans. Royal Soc.Trop.Med. & Hyg., Vol. XXXII. No.3. p.229, 1938).

It is therefore obvious that strict international co-operation is essential in view of the greatly extended means of rapid communication between those countries, and this should prove the more easy of decision and enforcement as the Americas are free from the threat of general war which stultifies all plans for co-operation in Africa and makes the spread of the disease to Asia an ever-present menace.

It must be noted that those countries which still remain devoted to the ideal of internation co-operation from a political and military stand-point are those upon which the actual responsibility for the control of Yellow Fever in Africa must rest, to wit, Great Britain and the Union of South Africa, France and Egypt.

Great Britain and Egypt with the Union, form a geographical continuity, which, under complete control, would be a barrier against the spread of the disease to the East

Coast, and by the same token, constitute the first line of defence for Asia.

Fron North to South, we have Egypt, Anglo-Egyptian Sudan, Uganda, Kenya, Tanganyika, Northern and Southern Rhodesia, and the Union of South Africa.

Although Egypt is now a political entity, her interests are British interests, nor is her position directly threatened.

Our ancient friendship with Portugal would ensure the co-operation of Mozambique and Angola, while France controls the great part of the rest of the continent.

The Belgian Congo would give added strength to the barrier, and as one of the main traffic routes lies across that territory, it is in her interests to co-operate and therefore she undoubtedly would.

There remains outside the system only Libia and Ethiopia with a small occupation of Spain in the North-West in addition to Liberia.

Now that France is probably also out of the picture, the main responsibility devolves on the British Commonwealth, who control an unbroken line of territory across the advance of the disease.

Nothing and no one can pass from the endemic West to the East without traversing British controlled land or water; the Commonwealth alone can take the necessary steps without

the prior aid of other nations.

Statements of principle are the province of scientific writers, but action, that of Governments.

The intellectual conception of the complete control and possible eradication of Yellow Fever in Africa is a magnificent ideal but so also is the responsibility tremendous, and in my opinion, only money and force, self-interested, can accomplish that ideal.

Great Britain accepted such a responsibility when she extended her power to the East where between a fourth and fifth of the human race live.

Great Britain would be answerable to Asia were she to shirk the use of the power she has acquired through the centuries for the defence of her trusting dependents.

We know where we are, in quarantine, larval extermination, viscerotomy and vaccination; the necessary weapons are to hand, how are they to be applied in time to prevent a great disaster?

Recently we have witnessed the people in the majority, accept a clean break with sacred tradition in terms of commitments and conscription. This was only made possible by bringing home to the man in the street, a pressing danger.

Yellow Fever spread is such, and in my opinion, only a break with tradition by granting dictatorial power to the medical officer selected, will accomplish the desired result.

Only by such power did Gorgas create the Canal Zone.

The onus of producing the initial atmosphere is laid on the medical profession. The onus of delegating the power and the means is upon the Government.

"Where there is no vision, the people perish."

S U M M A R Y.

HISTORICAL SURVEY, EPIDEMIOLOGY AND GEOGRAPHICAL DISTRIBUTION.

Special emphasis has been given to the Historical Survey covering, as it does, a discussion of the probable country of origin of the disease, showing how, and why it spread to the West, its influence on commercial, political and military affairs both in the area of origin and in those areas in which it gained either endemic or epidemic prominence, and the contrasts and comparisons which may be deduced from a study of its ravages in the West in contemplating the result of a spread to the East. The relation of spread to war, and the critical position and responsibility of the British Empire in Africa and the East, has been made a point of major importance.

A Survey has been made of all the factors controlling the man-mosquito-man cycle.

The Entomological, Zoological, Meteorological, Geographical, Social, Religious and Military elements which influence the spread and permanence of the disease have been discussed. It has been shown that notwithstanding the immense amount of new light which has been thrown on the cause of the disease and the discovery of new and precise

methods of diagnosis and epidemiological research, the aim and method of control remains fundamentally the same.

The geographical distribution of the disease from the year 1800, is shown by means of charts. (Vide Appendix).

CLINICAL FEATURES.

Only a cursory account of the clinical features has been given, including pathology and treatment. Emphasis has however been laid on differential diagnosis and the difficulty in determining mild or ambulatory cases, especially in children, and the new means of so doing. It has been stressed that this difficulty is the strongest argument in favour of Aedes aegypti control, particularly at points of possible entrance in the East.

ETIOLOGY AND TRANSMISSION.

In this section there is shown how from the discovery in 1928, by Stokes, Bauer and Hudson, of the nature of the infection, and that man was not the only animal which could carry the virus, there has emerged two factors of paramount importance enriching our armamentarium towards the elimination of the disease. The one, the protection test, the other, vaccination.

These discoveries have been discussed as well as some personal observations on the life and habits of Aedes aegypti, noting particularly the essential similarity of the

American insect to the Eastern insect, and its implications.

PROPHYLAXIS AND CONTROL.

A comparison has been made between the attitude of the sanitarians in the West and in the East, showing that the ultimate factor in control is not the sanitarian but Government.

A survey has been made of the work already done by the countries concerned, locally, nationally and internationally, with the reports of various congresses on Hygiene, including the regulations of the Permanent Committee of the Office International d'Hygiène Publique of the League of Nations.

The difference has been stressed between the East and West in terms of the new dangers.

A description has been given of the work of control in Brazil, noting both successes and failures and elucidating the causes of the latter.

A review has been made of the influence of politics in control, local, national and international.

The international situation to-day has been summarized with special reference to the responsibility of the British Empire and the Union of South Africa.

The possibility of the war involving endemic Yellow Fever areas, and the slackening or complete breaking of established sanitary cordons is exposed.

C O N C L U S I O N S.

(1) For centuries Yellow Fever has been a major disaster to the social and commercial life of the countries involved.

(2) With the knowledge we now possess, Yellow Fever can be eradicated.

(3) The Onus of eradication devolves upon Government.

(4) Special responsibility rests upon the British Empire.

(5) War is the factor of paramount danger as a means of extension to the East.

(6) We are faced with the proposition, is man a maker or a victim of his history?

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A P P E N D I X.

APPENDIX I.

THIS TRANSLATION SHOWS NATIONAL POLITICS IN REFERENCE TO THE CAMPAIGN. IT ALSO PROVES THAT RIO DE JANEIRO HAD BEEN WARNED, CONTRARY TO THE RECENT STATEMENT OF DR. SOPER AS QUOTED IN THE SECTION ON "CONTROL."

A FALSE CIVIC PRIDE PREVENTED THE CITY FROM HEEDING THE WARNING THAT THE ENEMY WAS AT HER GATES, WHERE IT ARRIVED IN 1928-29.

THE STATEMENTS AS REGARDS THE COMPOSITION OF THE PERSONNEL OF THE COMMISSAO IS PARTLY TURE, ONLY TWO OF THE DIRECTORS OF STATES WERE QUALIFIED AT THIS TIME.

MY OWN WARNING TO THE COMMISSAO, AS QUOTED, UNDER "CONTROL" WAS FLOUTED.

AGAIN "REGIONAL ENDEMICITY" IS EXPOSED.

APPENDIX I. (contd).

Translation from the "DEUTCHE ZEITUNG" Sao Paulo, Brazil.

June 19th, 1926.

"A Rio paper has just published a conversation with Dr. Carlos Seidl, Chief of the National Board of Health, on the subject of the epidemic of Yellow Fever which has broken out again in various Northern States."

"Dr. Seidl's opinion on the possibilities of a further spreading of this fearful disease is not exactly encouraging, and the Papers which have just arrived from Bahia, give strong foundation for his fears."

"The Yellow Fever is raging in its worst form in the North East of that particular State."

"In Bomfim, Queimadas, Miguel Calmon, Joazeiro and other towns, a large number of fatal cases have been registered."

"In Miguel Calmon alone, according to reliable information, there have been 78 deaths."

"Among the Paulistaner troops who were sent North to fight the Rebels, and are still stationed in Bomfim, the fever has already claimed eight victims who were swept away in the course of a few days."

"In the meantime, the fever has already spread further from Bahia up the Rio Sao Francisco as far as the terminus for navigation in Minas, Pirapora, in fact in disturbing

APPENDIX I. (contd).

proximity to the most highly populated zone of the country."

" The sick registered in Pirapora were also all from the Garrison."

"The local Newspapers are almost universal in blaming the Rockefeller Commissao for the Epidemic, and strangely enough, they also disclose the fact that the Commissao is not composed of Doctors, or even medically trained people, but of retired soldiers, diamond diggers, retired teachers etc., A discovery which we pointed out several weeks ago, and to which the Press is again referring, that is the isolation of the Yellow Fever Bacillus by two young Bahia Doctors, might be of the greatest importance in the fight."

"The fever germ was discovered as we know by the great Japanese bacteriologist, Hideo Naguchi, but could not be studied owing to certain difficulties in the investigations."

"Now, there appears to be the possibility for bacteriological research, and with it a new prospect is revealed in the fighting of the evil, where up to the present, it had to be limited to prophylactic measures."

APPENDIX II.

TRANSLATION ILLUSTRATING THE USELESSNESS OF GOOD TACTICS WITHOUT SOUND STRATEGY.

STARTING A CAMPAIGN WITHOUT EXTENSIVE PRELIMINARY SCIENTIFIC SURVEY.

NEGLECT OF OUTPOST WORK.

MAKING PUBLIC PRONOUNCEMENTS WITHOUT DATA.

TRUSTING TO UNTRAINED LOCAL DIRECTORS.

THE CONSTANT POLITICAL FACTOR IN ALL CONTROL CAMPAIGNS.

APPENDIX II.

TRANSLATION FROM THE "DIARIO DE NOTICIAS" OF BAHIA.

July, 1926.

THE SMASH UP OF THE ROCKEFELLER FOUNDATION.
THE ILLUSION CONCERNING NORTH AMERICAN SCIENCE.

"In our former edition we had occasion to broach the subject of Yellow Fever in reference to the Rockefeller Commission, reaching the point of asking ourselves if perhaps this North American Society sought in agreement with the Sub-Secretary of Public Health, to deny the existence of this disease amongst us."

"In rapid analysis we proved clearly that the above-mentioned foreign Commission from all points of view neglected their duties and obligations, even evading fulfillment of its contract with the Government of Brazil."

"In this connection, our colleagues of the "COMBATE" in Sao Paulo point out that "years ago when the Rockefeller Commission assumed the management of the campaign against Yellow Fever in the North, there were people who doubted the proficiency of their efforts."

"Dr. Gustave Barroso, pupil of Oswaldo Cruz, and chief of this service in that part of the country, disagreeing with the plans given to him, asked to be exonerated from further connection with the Commission; and in Sao Paulo, Dr. Jose

APPENDIX II. (contd).

de Toledo Piza, in a lecture before the Medical and Surgical Society, not only protested against the relinquishing to foreigners the responsibility which Oswaldo Cruz and Emilio Ribas had responded to with the greatest success, but also doubted the efficacy of the new American method, consisting in breeding a special fish capable of destroying the larvae of Stegomyias, if we are not mistaken."

"Recently, the American Scientists proclaimed their task finished, pompously advertising the definite extinction of this disease."

"But while the work of the two great Paulistas has, up to date, not been shattered by the re-appearance of Typho-Icteroide in Rio or Sao Paulo, the work of the Rockefeller Commission has been completely answered by the facts."

"The Sao Paulo people, as well as we, deny the carelessness of the much lauded efforts of the Commission Rockefeller with all their scientific baggage with reference to the campaign against Yellow Fever."

"Did not the Rockefeller people loudly proclaim and officially confirm that the disease now spreading amongst us was under control, snuffed out and extinct?"

APPENDIX II. (contd).

"And now, what excuse have they, What reasons can the North American Commission give to pardon such an official promulgated scientific lie?"

"Yellow Fever, incontestably, is spreading without encountering barriers or impediments in a large part of the State."

"How then explain the supposed extinction of Yellow Fever in Bahia?"

"By one means only, says conscience, in one way only shouts the TRUTH!"

"BY NORTH AMERICAN BLUFF."

APPENDIX III.

CASES OF YELLOW FEVER ADMITTED TO THE STRANGERS' HOSPITAL, RIO DE JANEIRO, SINCE ITS OPENING.

August, 1925.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1893	2		3	5	6		1						17
1894	6	60	42	25	2	2							137
1895			4	6	8						2		20
1896	7	8	36	13	5	2							71
1897	1	3		1									5
1898	1	1	14	8	3	5	2	1					35
1899	5	3	5	4	1	2	2			2	1	7	32
1900	1	2	7	7	2	2							21
1901		1	1	7	1	1		1	1				13
1902		2	2	9	8	2	10	4			1	1	39
1903	3	6	13	7	3			1					33
1904	1				1								2
1905				1	1	1							3
1906		1		1									2
1907					1 (last case)								1
	27	87	127	94	42	17	15	7	1	2	4	8	451

Off Ships: 154 or 35.4%
Mortality: 157 or 36.4%

APPENDIX III. (Contd).

March was also the month in which there was highest mortality, most of the ship cases arriving in the so-called "Aesthenic" stage with anemia and black vomit.

APPENDIX III.(Contd).

RECORD OF FOREIGNERS INTERRED IN THE BRITISH CEMETERY (GAMBOA) FROM 1811 to 1924, INCLUSIVE, ALMOST ALL BEING BRITISH SUBJECTS.

Compiled from: -

1. Interment Books and Certificates.
2. Christ Church Register, 1811-1925, (1816-1821 missing).
3. Undertakers' Records.
4. Interment Books at Cemetery.
5. Graves themselves.
6. Cash Books for Appropriation Fees.

PRE-YELLOW FEVER PERIOD.

	Jan.	Feb.	Mar.	April.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total.
1811	1	0	3	0	0	0	0	0	0	0	0	0	4
1812	0	1	1	1	5	0	1	2	0	1	2	1	15
1813	0	0	1	3	2	2	0	1	0	0	4	5	18
1814	2	1	0	3	1	2	2	0	5	1	1	2	20
1815	9	4	3	6	5	3	0	8	0	1	0	0	39
				(No trace of further entries until 1822)									
1822					1	1	2	2	0	1	2	0	9
1823	1	1	3	1	3	4	2	1	2	1	4	3	26
1824	6	1	1	1	5	1	3	5	1	4	2	5	35
1825	4	5	2	1	3	4	3	4	1	3	1	1	32
1826	6	3	5	6	4	2	1	5	6	1	3	3	45
1827	3	7	4	4	6	3	4	2	1	7	2	4	47

(contd)

APPENDIX III. (Contd).

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1828	1	3	2	6	1	1	3	7	1	1	5	2	33
1829	2	3	1	1	4	3	1	5	3	1	1	10	35
1830	6	4	9	1	3	1	3	3	4	1	2	5	42
1831	7	5	7	1	5	3	5	0	3	2	0	2	40
1832	4	3		2	3	3	2	1	1	4	0	3	26
1833	4	2	6	2		2		4	2	2	3	2	29
1834	4	6	2	3	6	4	5	1	2	0	4	4	41
1835	5	1	3	1	3	4	5	5	1	3	1	3	35
1836	6	6	0	1	5	2	0	4	1	0	1	3	29
1837	5	1	4	2	0	2	4	2	2	4	3	3	32
1838	1	2	1	2	4	1	3	3	2	1	0	2	22
1839	1	1	2	2	2	4	1	1	6	0	1	3	24
1840	4	1	0	2	1	0	1	0	1	2	6	2	20
1841	2	0	1	2	4	1	3	1	3	4	3	1	25
1842	3	3	6	1	3	5	7	4	6	5	5	5	53
1843	8	9	3	6	7	4	6	4	7	4	4	9	71
1844	5	4	4	9	2	3	4	2	3	4	8	11	59
1845	3	0	5	4	3	0	0	1	1	5	7	9	38
1846	6	5	8	2	8	5	6	4	5	8	6	4	67
1847	9	10	9	2	5	5	7	5	3	11	1	11	78
1848	12	12	9	7	4	3	4	2	8	2	4	11	78
1849	14	1	10	7	8	4	0	6	6	12	1	13	82
	144	105	115	92	116	82	88	95	87	96	87	142	1249

APPENDIX III. (CONTD)

Yellow Fever Period.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total.
1850	15	46	94	51	43	9	4	9	0	1	0	3	275
1851	6	14	29	22	13	11	5	1	7	4	4	3	119
1852	10	23	56	30	41	18	13	13	7	12	6	23	252
1853	22	20	40	18	12	12	5	4	11	3	4	3	154
1854	2	2	1	9	1	5	8	4	1	5	1	8	47
1855	2	2	7	5	5	10	4	1	7	2	5	2	52
1856	4	5	3	9	6	6	0	2	6	1	0	4	46
1857	3	10	11	10	5	2	3	5	4	6	2	3	64
1858	6	24	20	5	6	6	0	3	2	0	2	1	75
1859	3	4	10	4	5	3	3	1	2	2	0	2	39
1860	3	5	8	9	12	7	5	1	1	3	5	4	63
1861	4	5	5	1	1	5	5	0	5	1	3	1	36
1862	5	1	3	1	2	2	2	1	0	4	2	5	28
1863	1	3	2	1	2	1	2	0	3	1	0	4	20
1864	3	7	3	3	2	3	7	2	2	6	2	2	42
1865	2	1	3	2	0	1	0	0	4	0	2	0	15
1866	1	1	3	3	1	1	1	3	0	4	2	3	23
1867	0	1	3	2	3	3	3	1	1	0	1	2	20
1868	3	6	2	3	1	2	4	1	2	1	2	3	30
1869	2	1	4	8	5	4	8	3	2	4	1	6	48
1870	7	11	10	1	6	1	1	3	2	3	0	1	46

(contd)

APPENDIX III. (Contd).

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1871	3	1	3	4	4	3	0	2	3	3	3	2	31
1872	3	2	3	1	1	2	3	5	3	1	1	3	28
1873	13	19	13	5	9	4	6	3	2	4	2	6	86
1874	2	3	6	1	9	9	2	1	4	3	3	1	44
1875	1	3	7	5	5	5	0	3	1	2	2	2	36
1876	4	2	17	11	6	6	3	3	0	2	0	6	60
1877	4	3	6	4	4	0	1	1	2	1	1	1	28
1878	3	8	9	3	2	3	4	3	4	3	1	2	45
1879	6	7	10	1	3	3	4	2	4	1	1	0	42
1880	3	4	7	7	3	2	3	2	0	1	3	1	36
1881	3	1	2	2	2	1	0	0	1	2	2	1	17
1882	3	1	2	2	2	1	0	2	1	2	2	0	18
1883	1	1	0	6	4	0	4	3	1	6	0	0	26
1884	2	3	1	3	5	2	2	3	0	0	1	3	25
1885	1	2	2	2	2	1	1	2	0	1	1	0	15
1886	1	3	8	4	4	3	3	1	0	1	1	3	32
1887	4	1	4	1	4	2	0	0	0	1	1	1	19
1888	1	1	1	3	7	5	2	2	1	3	1	4	31
1889	3	12	11	5	3	3	2	2	5	3	0	0	49
1890	0	2	4	1	0	1	3	4	1	1	2	1	20
1891	3	7	4	12	7	4	8	5	4	5	2	10	71
1892	11	17	36	9	4	2	1	2	0	5	2	3	92
1893	2	0	3	6	4	3	4	1	2	1	6	4	36

(contd)

APPENDIX III. (Contd).

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1894	4	17	20	8	6	4	0	0	0	2	4	0	65
1895	2	1	3	7	3	0	3	0	1	1	1	5	27
1896	3	2	13	6	2	2	1	0	0	0	2	2	33
1897	1	2	2	4	0	0	0	1	1	2	0	4	17
1898	2	6	5	3	3	4	3	3	1	0	2	5	37
1899	2	3	9	1	2	1	2	1	1	3	2	1	28
1900	2	3	4	2	1	2	3	0	3	0	1	2	23
1901	0	4	0	1	2	0	2	2	4	1	2	0	18
1902	2	3	1	3	3	2	3	2	3	2	0	1	25
1903	0	4	0	1	2	0	0	0	1	1	0	1	10
1904	1	1	0	1	1	1	1	1	5	0	1	3	16
1905	1	0	2	0	3	0	1	1	1	3	1	4	17
1906	1	3	3	1	2	1	0	1	1	1	1	0	15
1907	0	2	0	2	3	0	1	0	1	0	2	1	12
	202	346	538	335	299	194	159	122	131	131	101	166	2724

APPENDIX III. (contd).

Post Yellow Fever Period.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1908	3	1	1	0	0	3	1	0	1	1	2	0	13
1909	1	0	1	0	0	0	1	1	2	2	1	1	10
1910	1	4	0	2	1	1	2	3	3	0	0	0	17
1911	1	0	0	0	0	1	0	1	1	2	2	1	9
1912	1	3	2	0	2	0	1	2	0	3	1	3	18
1913	1	0	0	0	0	2	0	0	1	1	0	3	8
1914	1	2	0	3	0	1	1	1	2	3	1	1	16
1915	2	2	0	0	0	3	1	1	2	1	1	1	14
1916	1	1	3	1	1	3	1	0	1	2	1	3	18
1917	2	0	1	0	0	2	4	0	0	0	2	4	15
1918	1	1	0	1	1	2	2	7	2	8	3	2	30
1919	0	1	1	2	0	0	0	0	1	0	2	2	9
1920	1	0	1	1	1	0	5	2	1	1	3	0	16
1921	1	2	3	1	2	2	1	3	1	0	4	0	20
1922	4	2	2	1	3	3	1	0	2	3	2	4	27
1923	1	2	1	3	1	1	2	1	0	3	2	1	18
1924	0	1	2	2	2	0	2	1	5	2	0	2	19
	22	22	18	17	14	24	25	23	25	32	27	28	277

APPENDIX III. (contd).

GRAND TOTALS FOR THE THREE PERIODS.

Year	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total.
Pre-Yellow Fever Period.													
1811-1849.	144	105	115	92	116	82	88	95	87	96	87	142	1,249
Yellow Fever Period.													
1850-1907	202	346	538	335	299	194	159	122	131	131	101	166	2,724
Post-Yellow Fever Period.													
1908-1924	22	22	18	17	14	24	25	23	25	32	27	28	277.
GRAND TOTAL.	368	473	671	444	429	300	272	240	243	259	215	336	4,250

NOTE: -

The highest mortality was always in MARCH.

Pre-Yellow Fever Period .. .. Mortality 9.2% of total for years.

YELLOW FEVER PERIOD .. .. Mortality 19.7% of total for years.

Post-Yellow Fever Period .. Mortality 6.4% of total for years.

The marked reduction in mortality in the Post-Yellow Fever Period in comparison with the Pre-Yellow Fever Period

APPENDIX III. (Contd).

was due to absence of Smallpox in the now vaccinated British, which was not started until 1872.

Compare "ANNUARIO DE ESTATISTICIA DEMOGRAPHIO SANITARIA." Rio de Janeiro. Vol. I., 1920-1921.

APPENDIX IV.

COPY OF A REPORT ON THE INTERIOR TOWNS OF THE STATE OF BAHIA, BRAZIL, FROM JANUARY TO MAY 1926, ILLUSTRATING REGIONAL ENDEMICITY.

THIS REPORT WAS MADE IMMEDIATELY AFTER BAHIA AND ALL BRAZIL HAD BEEN PROCLAIMED FREE OF YELLOW FEVER, SHOWING THE MISTAKE OF CONTROLLING ONLY THE MAIN ENDEMIC CENTRE.

IT ALSO ILLUSTRATES THE ILLUSION OF THE PFEIFFER REACTION.

APPENDIX IV.

Translated from Portuguese.

Places where suspected or confirmed cases of Yellow Fever have been verified in the Bahia-S. Francisco Railway sector and in the Bomfim-Mundo Nova, Franca branch. Statistical data for the Prophylaxis Department.

PLACES	APPROXIMATE NUMBER OF ESTATES	NUMBER OF INHABITANTS.	DISTANCE FROM BOMFIM IN KILOMETERS.
Alagoinhas	2,000	8,000	322
Queimadas	300	1,500	95
Itiuba	250	1,200	52
Carisca	20	150	12
BOMFIM	1685	7,000	--
Carrapichel	120	600	9
Estiva	20	100	12
Jaguarary	500	1,800	32
Barrinha	30	200	62
Jurema	50	250	92
Missao do Sahy	110	500	9
Campo Formosa	250	1,500	44
Saude	100	500	66
Jacobina	1500	6,000	121
Miguel Calmon	700	2,000	136
Mundo Novo+	1400	5,000	214

+ The railway spur from Franca to Mundo Novo is not yet

APPENDIX IV. (Contd).

in use. The last station is Franca, six leagues from Mundo Novo and in daily communication with this city.

APPENDIX IV. (Contd).

Explanatory table of Yellow Fever deaths in the Bahia-Sao Francisco Railway Sector, and the branch from Bomfim to Franca-Mundo Novo during the months of January to May, 1926.

PLACES	NUMBER OF FATAL CASES	OBSERVATIONS.
Alagoinhas	?	Supposed to have been very many.
Queimadas	?	
Itiuba	3	Two S.Paulo soldiers and a child.
Cariaca	1	One woman died in Bomfim.
Bomfim.	8	Three were S. Paulo soldiers infected in Itiuba, two were soldiers coming from Jacobina, one patient coming from Carrapichel (male), one woman coming from Missao and another who died in Palmeiras estate. No cases observed among inhabitants of the city.
Carrapichel	10	All infected in Carrapichel.
Estiva	2	Infected in Carrapichel.
Jaguarary	8	Infected in Jaguarary.
Barrinha	3	Infected in Barrinha.

APPENDIX IV. (Contd).

PLACES	NUMBER OF FATAL CASES	OBSERVATIONS.
Jurema	2	Reported by Dr. Antonio Gonçalves from Cunha e Silva.
Massão do Sahy	13	From April 13 to May 31.
Campo Formoso	?	Suspected cases occurred among soldiers of Paes Leme Battalion, according to information of military physician, Dr. Alcen Navarro.
Saude	1	Patient died in Cannavieiras estate.
Jacobina	2	Patients came from Miguel Calmon on fifth day of disease.
Miguel Calmon.	78	From January 1 to April 15.
Mundo Novo	?	Endemic center since 1922, and from February of this year up to the present innumerable cases have been reported according to information from Dr. Adalberto Campos. (Note: written in ink: Small town of 5,000.)

APPENDIX IV. (contd).

CASES OF YELLOW FEVER IN BAHIA CITY, 1926.

Germano Hinzi - 29 Gravata Street. Coming from Alagoinhas, May 11.

Custodio de Carvalho - May 21. Soldier. Military Hospital, coming from Jacobina Franca. (Died).

Ulysses Mendes - Soldier. Military Hospital. May 11. Coming from Queimados. (Died).

Joaquim Agusto Dias - Portuguese. Becco do Bambu No.9 Calcada Street. May 6. (Died). This case was infected in the city of Bahia.

Jose Gabriel Freire de Castro - Coming from Alagoinhas. May 22, 21 Chile Street. (Died).

APPENDIX IV. (Contd).

Bahia, June 10, 1926.

Index in recent days in the interior of the State.

Sao Felix	14.4
Cachoeira	14.4
Bomfim	18.6
Muritiba	36.4
Santa Luzia	4.4
Joazeiro	28.5
Santo Amaro	22.3
Nazareth	22.4

APPENDIX IV. (Contd).

Pfeiffer's reaction with the serum of patients of Miguel Calmon. (Bahia).

Name of Patients.	Place of Origin	Result.
Jeronymo Castão	Miguel Calmon.	Negative.
Esmeraldo Dias Rios.	" "	"
Severo Correia	" "	"
Joaõ de Moura Vieira.	" "	"
Maria de Silva Alves.	" "	"
Epaminondas Prado.	" "	"
Joanna Monte Santo.	" "	"
Sebastião Gali.	" "	"
João Rocha.	" "	"
Elias Schneiberg.	" "	"
Antonio Rios.	" "	"
Guilherme Rios.	" "	"
José do Prado Alves.	" "	"
Laurinda Rios.	" "	"

Bahia, June 11, 1926.
Josephine França
Stenographer.

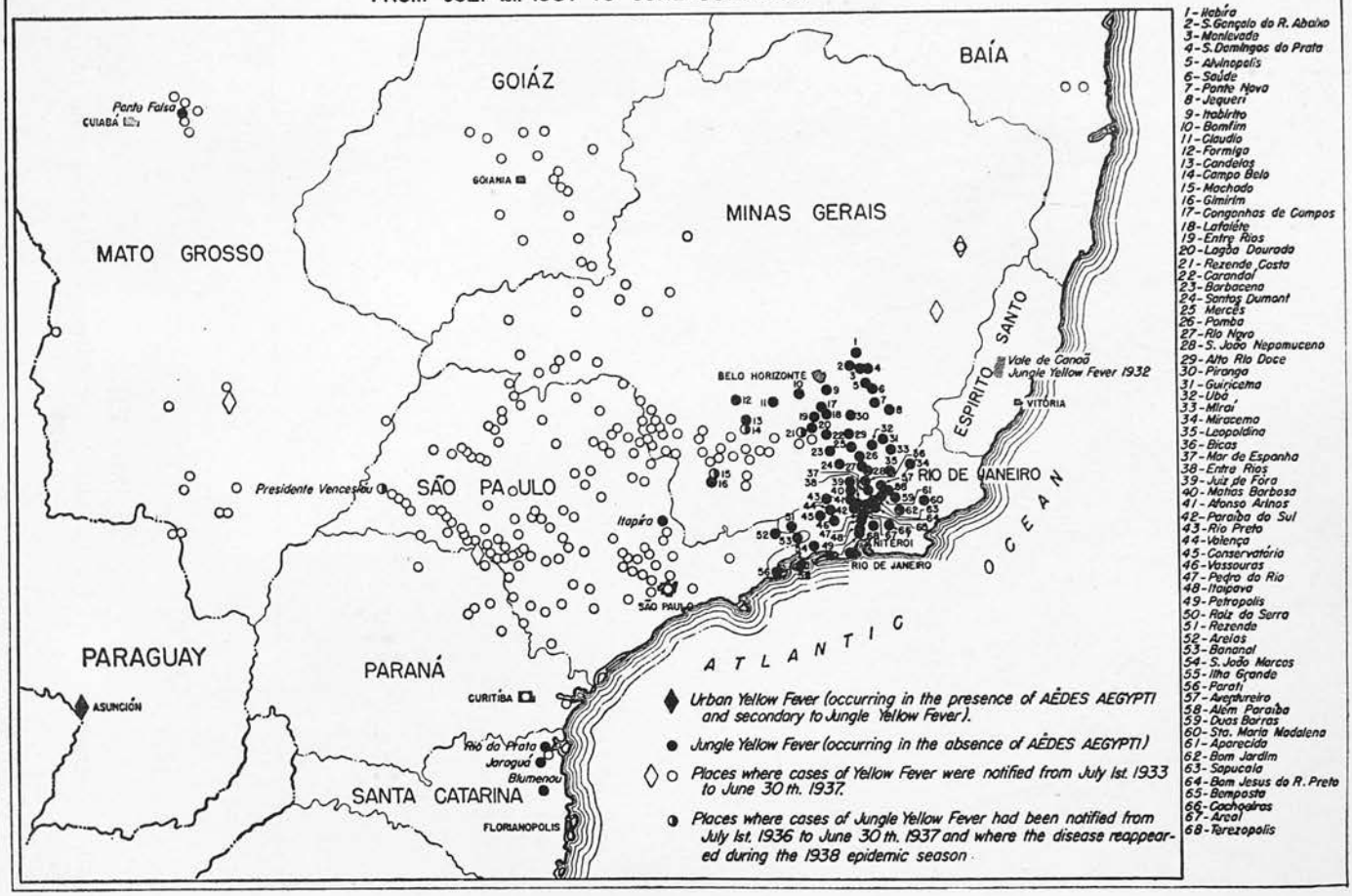
These Pfeiffers were made at the Oswaldo Cruz Institute by State doctors.
(Signed) C.H.

Note Negative result of Pfeiffer's Reaction in 14 cases of Clinical Yellow Fever. Compare Noguchi & Stokes.

12 charts and maps showing latest knowledge of distribution of Yellow Fever in South America. Taken from "Transactions of the Royal Society of Tropical Medicine and Hygiene". Vol.XXXII. No. 3. November 1938.

LOCALITIES IN SOUTHERN BRAZIL AND PARAGUAY WHERE YELLOW FEVER CASES WERE NOTIFIED FROM JULY 1st. 1937 TO JUNE 30th. 1938.

(1)

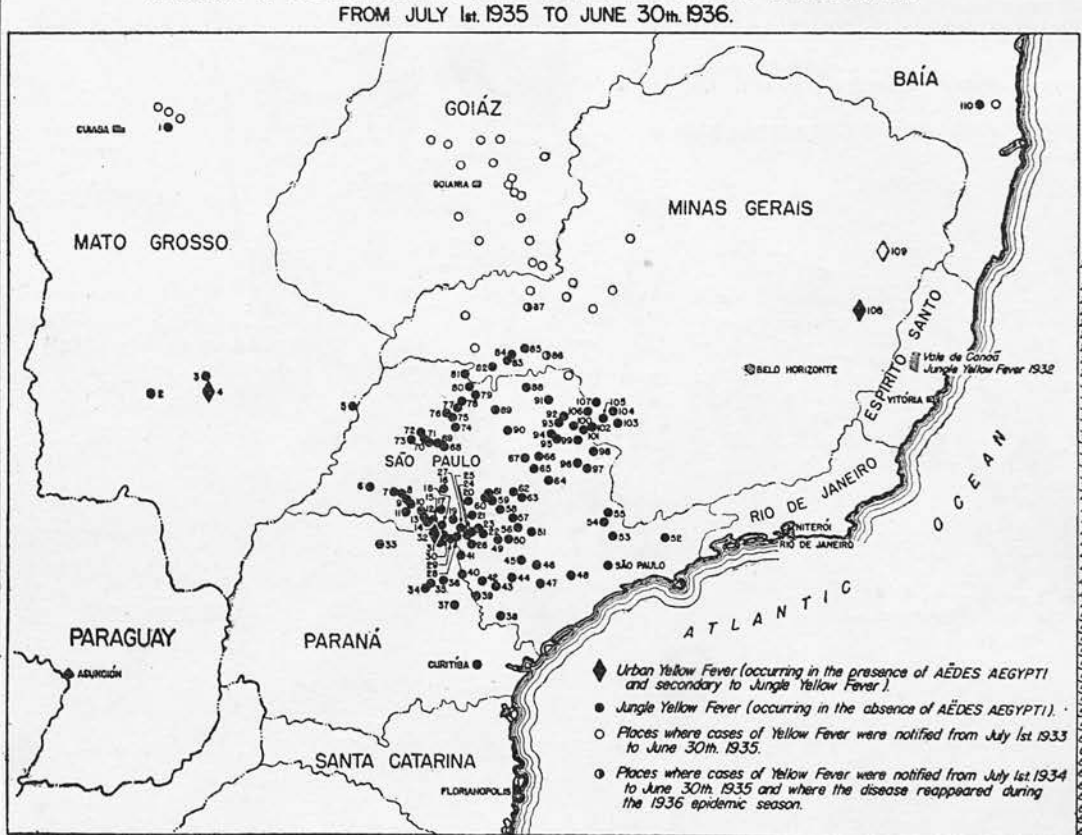


1 - Itabira
2 - S. Gonçalo do R. Abaixo
3 - Manlevade
4 - S. Domingos do Prata
5 - Alvinopolis
6 - Saúde
7 - Ponte Nova
8 - Jequeri
9 - Itabirito
10 - Bomfim
11 - Claudio
12 - Formiga
13 - Candeias
14 - Campo Belo
15 - Machado
16 - Gimirim
17 - Congonhas de Campos
18 - Lafaiete
19 - Entre Rios
20 - Lagôa Dourada
21 - Rezende Costa
22 - Carandaí
23 - Barbacena
24 - Santos Dumont
25 - Mercês
26 - Pomba
27 - Rio Novo
28 - S. João Nepomuceno
29 - Alto Rio Doce
30 - Piranga
31 - Guiricema
32 - Ubá
33 - Miraí
34 - Miracema
35 - Leopoldina
36 - Bicas
37 - Mar de Espanha
38 - Entre Rios
39 - Juiz de Fóra
40 - Matias Barbosa
41 - Afonso Arinos
42 - Paraiba do Sul
43 - Rio Preto
44 - Valença
45 - Conservatória
46 - Vassouras
47 - Pedro do Rio
48 - Itaipava
49 - Petropolis
50 - Rolz da Serra
51 - Rezende
52 - Arelas
53 - Bananal
54 - S. João Marcos
55 - Ilha Grande
56 - Parati
57 - Areptureiro
58 - Além Paraiba
59 - Duas Barras
60 - Sta. Maria Madalena
61 - Aparecida
62 - Bom Jardim
63 - Sapucaia
64 - Bom Jesus do R. Preto
65 - Bemposta
66 - Cachoeiras
67 - Arcol
68 - Terezopolis

MAP VI.

LOCALITIES IN SOUTHERN BRAZIL WHERE YELLOW FEVER CASES WERE NOTIFIED FROM JULY 1st. 1935 TO JUNE 30th. 1936.

(3)

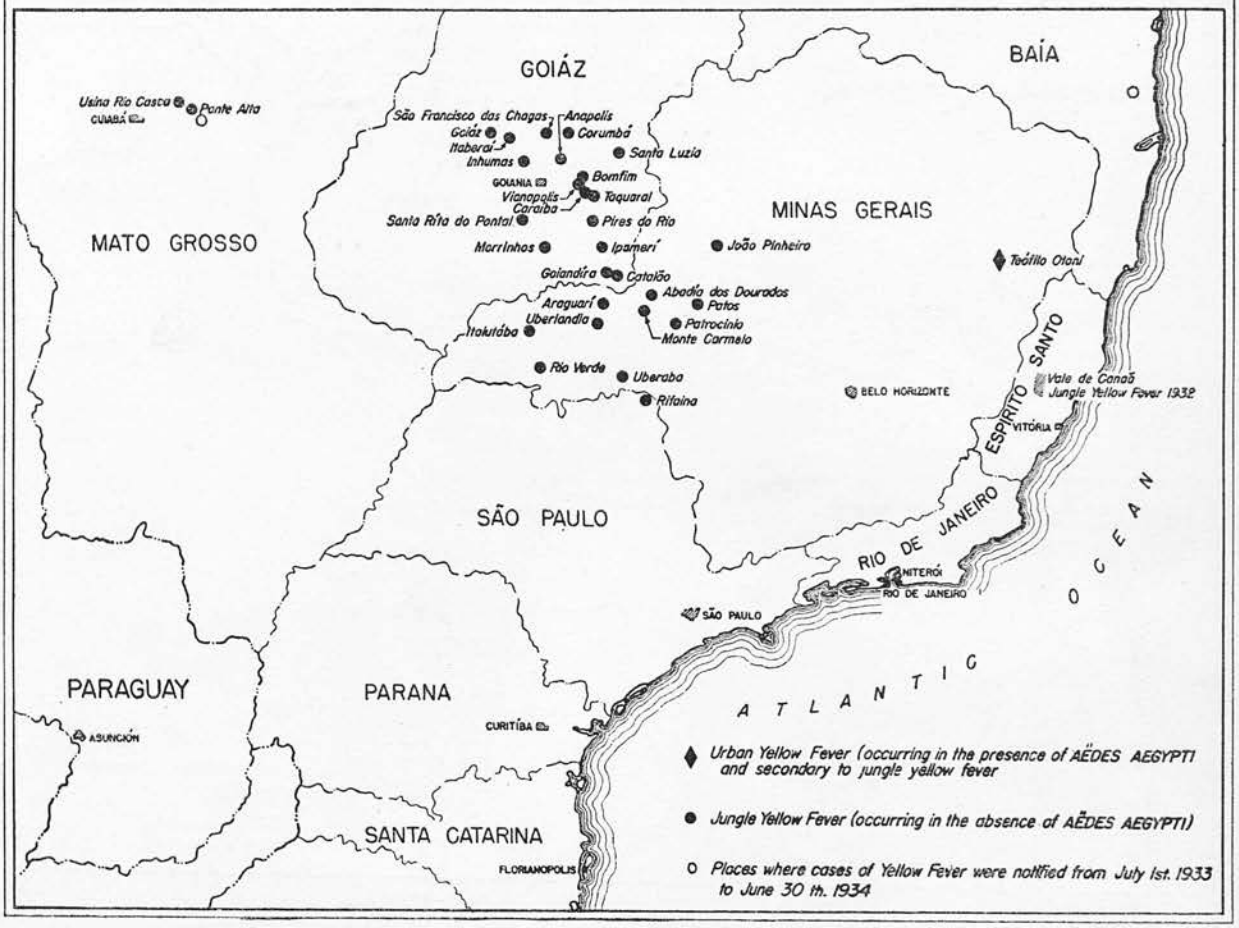


1 - Jaticá
2 - Aquidauana
3 - C. Grande neighborhood
4 - Campo Grande
5 - Três Lagôas
6 - Presidente Prudente
7 - Rancharia
8 - Quatá
9 - Sapesal
10 - Paraguassú
11 - Maracaí
12 - Assis
13 - Candido Mota
14 - Sussuí
15 - Potnital
16 - Marilia
17 - Campos Novos
18 - Salto Grande
19 - São Pedro do Turvo
20 - Duartina
21 - Espirito Santo do Turvo
22 - Cerqueira Cesar
23 - Santa Barbara do R. Pardo
24 - Olsa
25 - Bernardino de Campos
26 - Pirajú
27 - Santa Cruz do Rio Pardo
28 - Ipaussú
29 - Chavantes
30 - Ourinhos
31 - Jacarézinho
32 - Cambará
33 - Londrina
34 - Barra Bonita
35 - Arthur Bernardes
36 - Tomazina
37 - Jaguariaiva
38 - Apiaí
39 - Itararé
40 - Itaporanga
41 - Fartura
42 - Itaberá
43 - Faxina
44 - Buri
45 - Angatuba
46 - Itapetininga
47 - São Miguel do Arcanjo
48 - Piedade
49 - Avaré
50 - Pilar
51 - Piramboia
52 - Tremembé
53 - Bragança
54 - Amparo
55 - Serra Negra
56 - Batuatí
57 - São Manuel
58 - Lençóis
59 - Agudos
60 - Pirathinga
61 - Bauru
62 - Jau
63 - Dois Corregos
64 - São Carlos
65 - Araraquara
66 - Rincão
67 - Marilia
68 - Avanhandava
69 - Pongpolis
70 - Corbadas
71 - Birigui
72 - Araçatuba
73 - Guararapes
74 - José Bonifacio
75 - Mirandi
76 - Vila Polori
77 - Monte Aprazivel
78 - Tonabi
79 - Nova Granada
80 - Palestina
81 - Potos
82 Frutal
83 - Douradas
84 - Dores do C. Formoso
85 - Varissima
86 - Uberaba
87 - Uberlandia
88 - Guaira
89 - Olimpia
90 - Pirangi
91 - São Joaquim
92 - Batatais
93 - Brodowsky
94 - Ribeirão Preto
95 - Vila Bomfim
96 - Tambaí
97 - Casa Branca
98 - Mococa
99 - Cajurú
100 - Altinopolis
101 - Santa Ant. do Alegria
102 - Arari
103 - Alpinopolis
104 - Passos
105 - Santa Cruz das Areias
106 - São Tomaz da Aquina
107 - Santa Rita de Cassia
108 - Piquera
109 - Teófilo Otoni
110 - Itauna

MAP IV.

(5)

LOCALITIES IN SOUTHERN BRAZIL WHERE YELLOW FEVER CASES WERE NOTIFIED FROM JULY Ist. 1934 TO JUNE 30th. 1935.

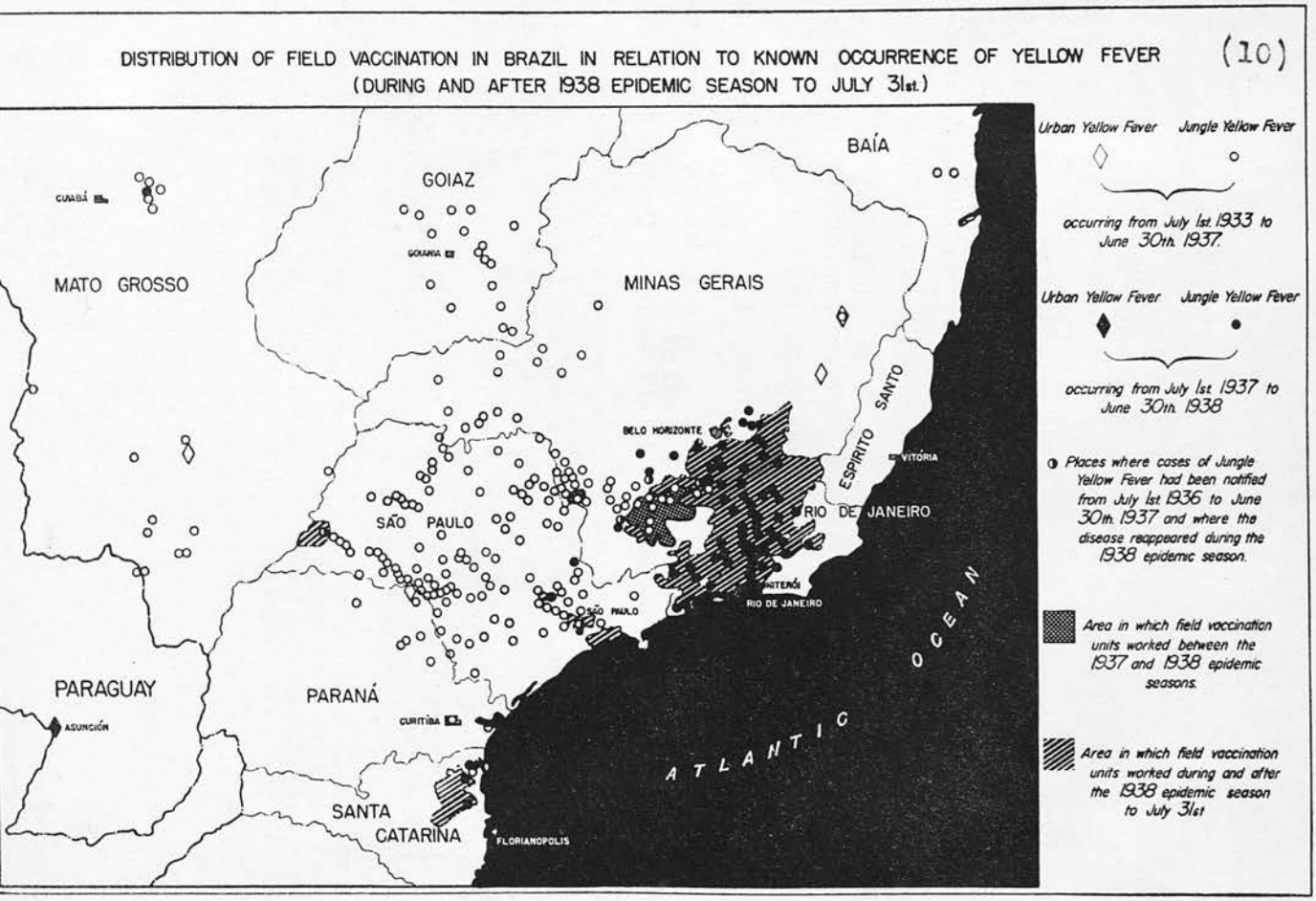


MAP III.

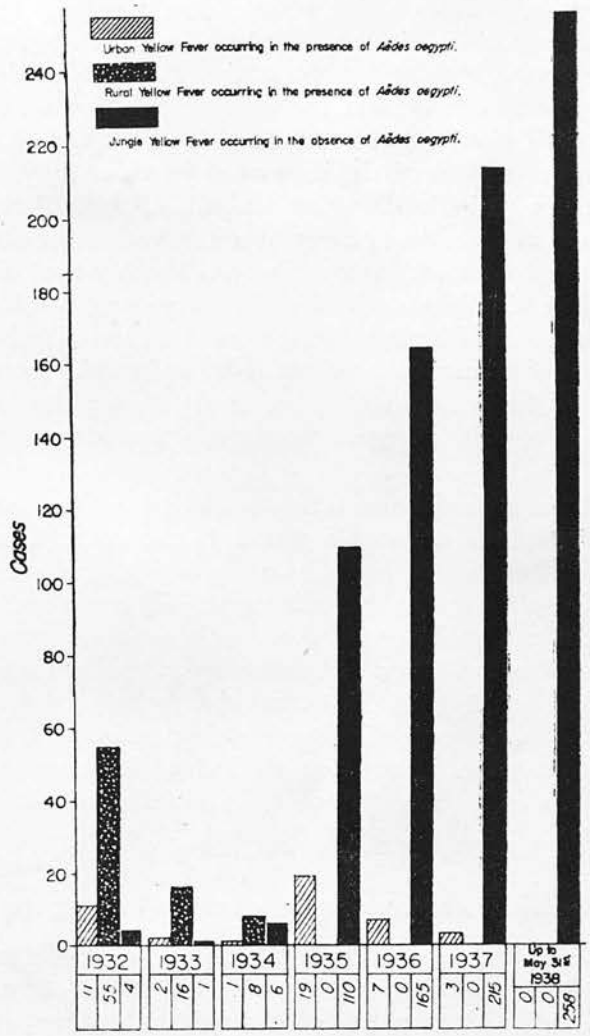
MAP I.—South American localities where cases of jungle yellow fever have been diagnosed, 1932—1938.

MAP VIII.

BRAZIL.—Places in which anti-larval and adult mosquito capture services were in operation during the first quarter of 1938.


DISTRIBUTION OF FIELD VACCINATION IN BRAZIL IN RELATION TO KNOWN OCCURRENCE OF YELLOW FEVER
(DURING AND AFTER 1938 EPIDEMIC SEASON TO JULY 31st.)
(10)
BAÍA
GOIAZ
CUIABÁ
GOIANIA
MATO GROSSO
MINAS GERAIS
ESPIRITO SANTO
BELO HORIZONTE
VITÓRIA
SÃO PAULO
RIO DE JANEIRO
NITERÓI
RIO DE JANEIRO
SÃO PAULO
PARAGUAY
PARANÁ
ASUNCIÓN
CURITIBA
SANTA CATARINA
FLORIANOPOLIS
ATLANTIC OCEAN
Urban Yellow Fever
Jungle Yellow Fever
occurring from July 1st 1933 to June 30th. 1937.
Urban Yellow Fever
Jungle Yellow Fever
occurring from July 1st 1937 to June 30th. 1938
Places where cases of Jungle Yellow Fever had been notified from July 1st 1936 to June 30th 1937 and where the disease reappeared during the 1938 epidemic season.
Area in which field vaccination units worked between the 1937 and 1938 epidemic seasons.
Area in which field vaccination units worked during and after the 1938 epidemic season to July 31st

MAP X.



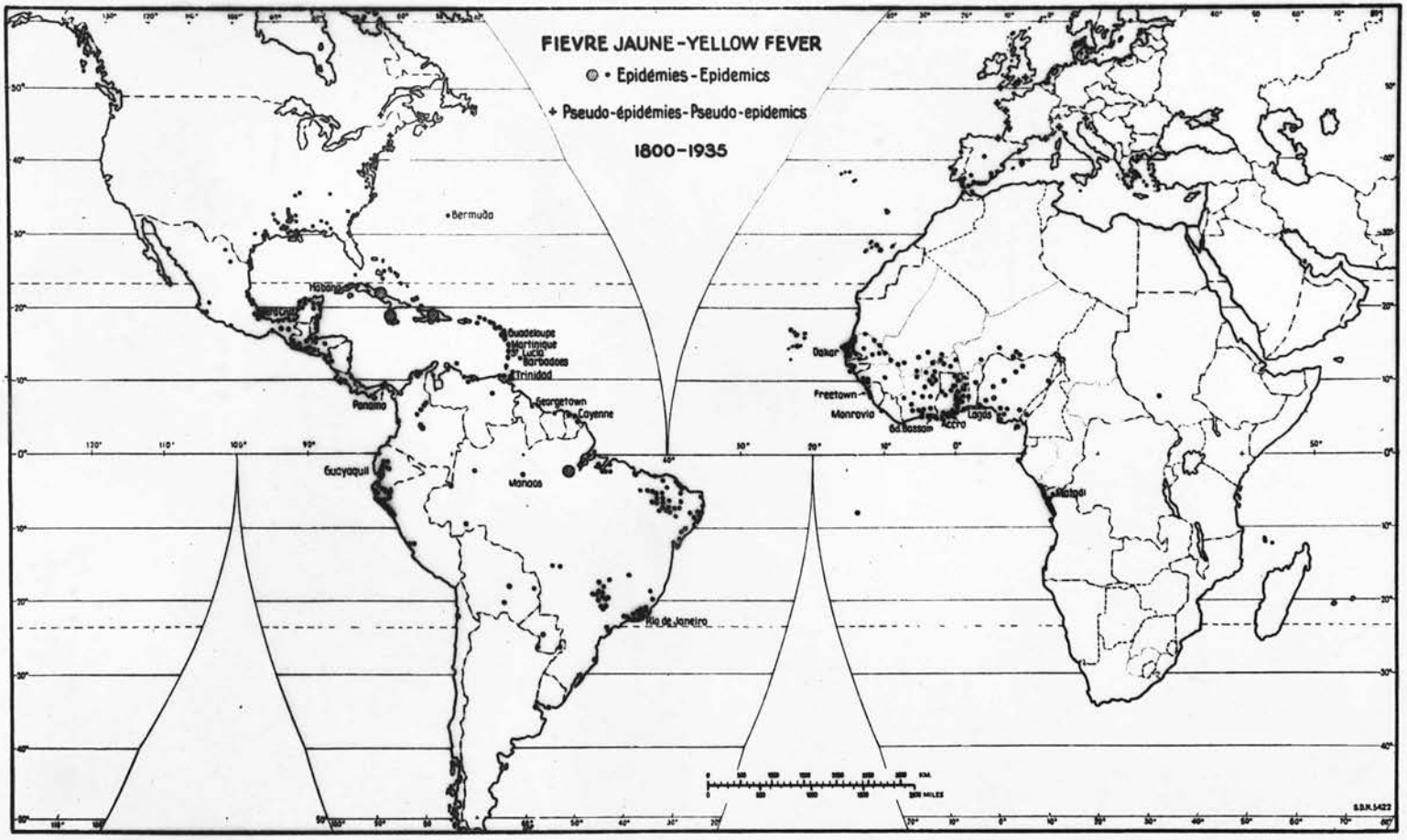
GRAPH.—Confirmed cases of yellow fever in Brazil from January, 1932 to May, 1938.

URBAN, RURAL AND JUNGLE YELLOW FEVER IN BRAZIL FROM 1932 TO MAY, 1938. (12)

Type of Yellow Fever.	1932.	1933.	1934.	1935.	1936.	1937.	1938.
Aegypti-transmitted							
Urban	11	2	1	19	7	3	0
Rural	55	16	8	0	0	0	0
Non-aegypti-transmitted							
Jungle	4	1	6	110	165	215	258
Total	70	19	15	129	172	218	258

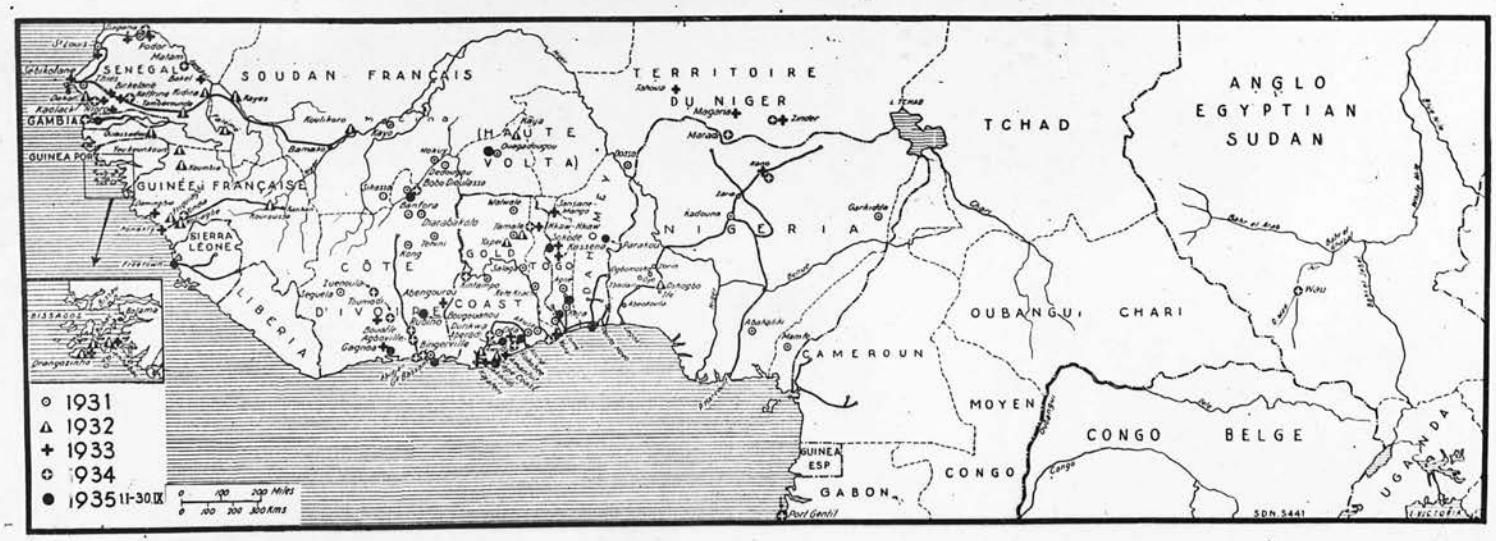
8 Photostatic copies of charts taken from "Rapport Epidemiologique de la Section d'Hygiene du Secretariet" Societe des Nations. R.E. 179. showing distribution of Yellow Fever.

CARTE 1. — MAP 1.


FIEVRE JAUNE-YELLOW FEVER
• Epidémies-Epidemics
+ Pseudo-épidémies-Pseudo-epidemics
1800-1935
Bermuda
Habana
Guadeloupe
Martinique
Ste Lucie
Barbadoes
Trinidad
Panama
Georgetown
Cayenne
Guayaquil
Manaos
Rio de Janeiro
Dakar
Freetown
Monrovia
Gd Bassam
Accra
Lagos
Matadi

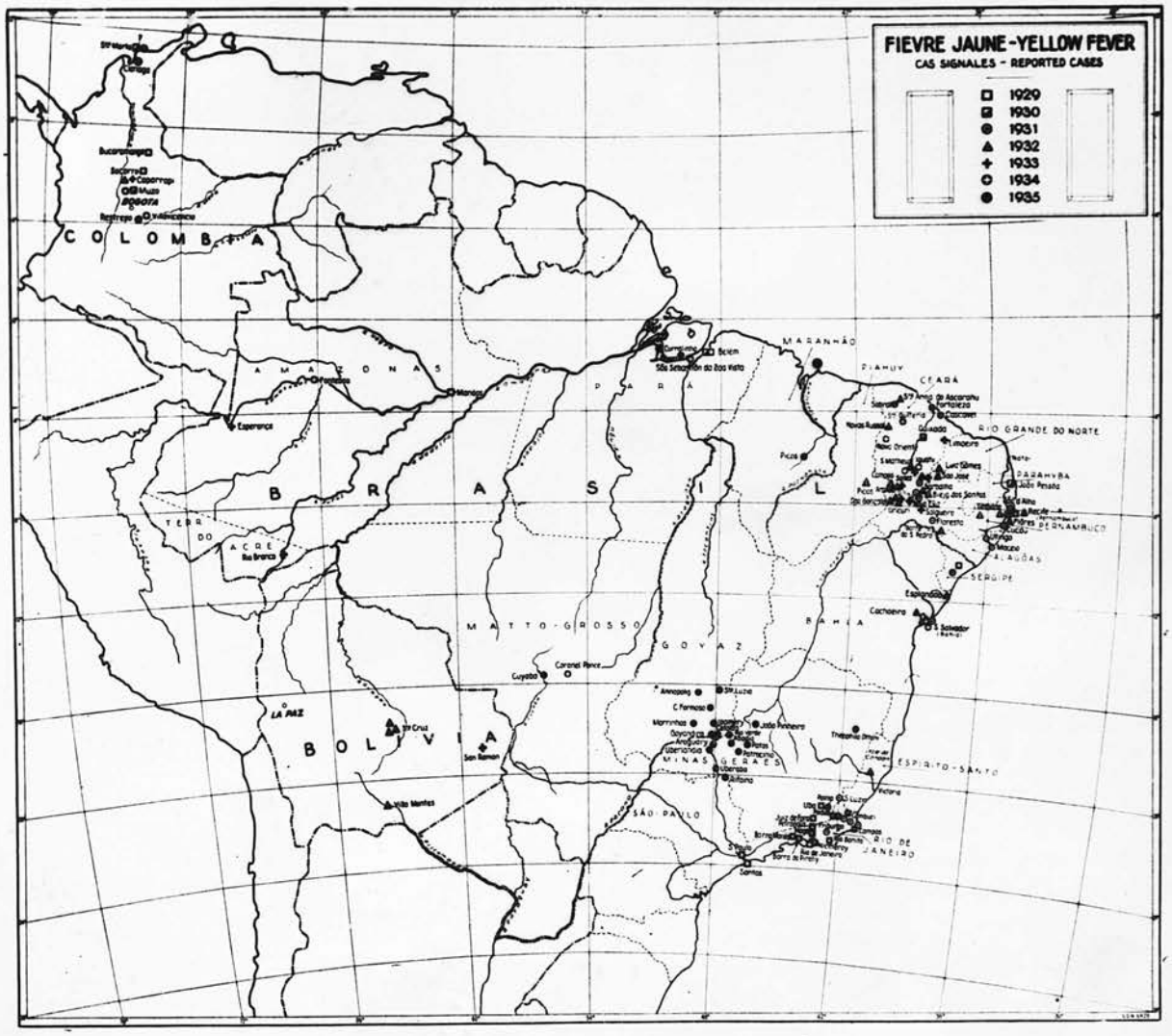
2. Répartition des cas de fièvre jaune signalés en Afrique.
2. Distribution of Yellow-fever Cases reported in Africa.

I.1931 — IX.1935.

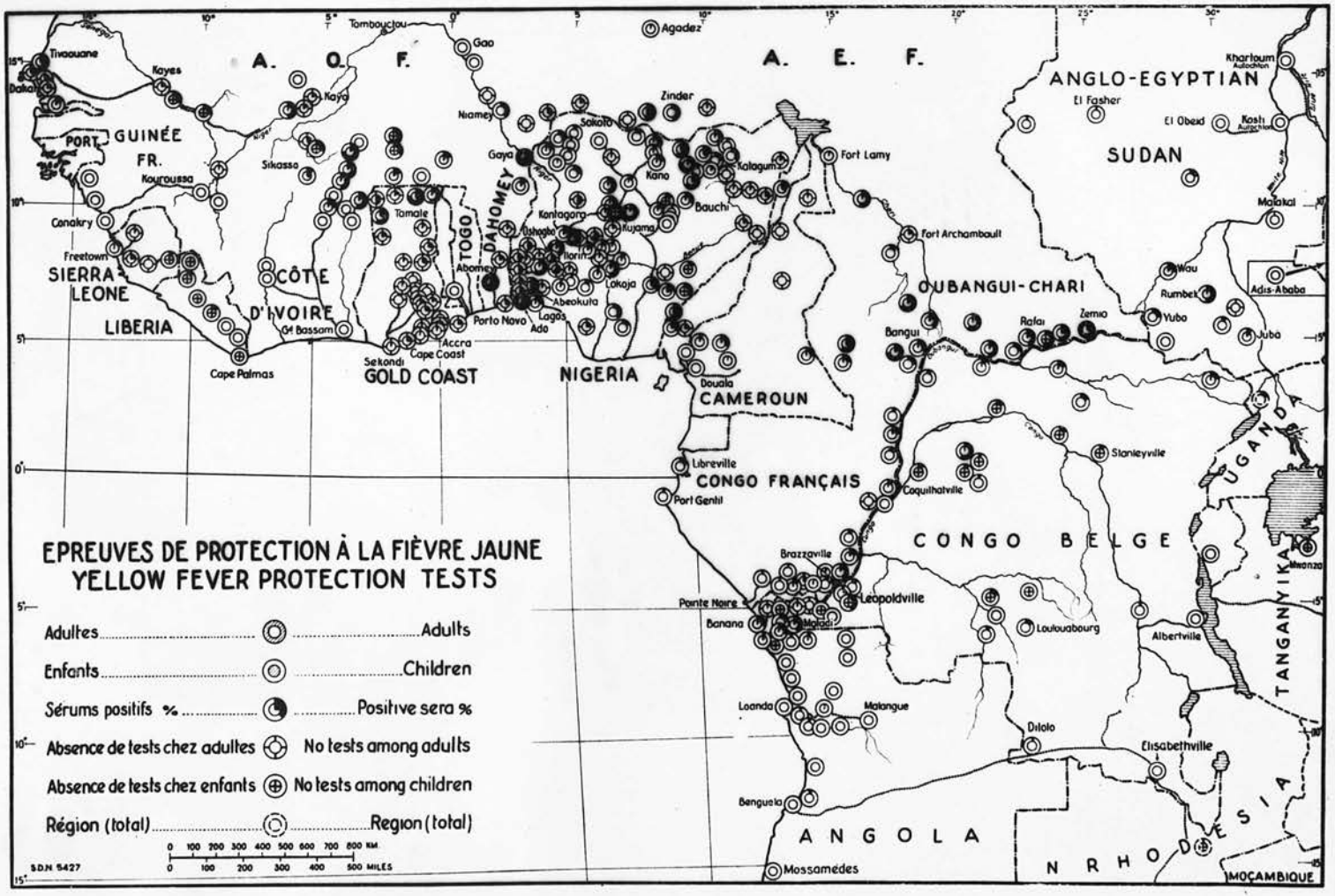


3. Répartition des cas de fièvre jaune signalés en Amérique du Sud.
3. Distribution of Yellow-fever Cases reported in South America.

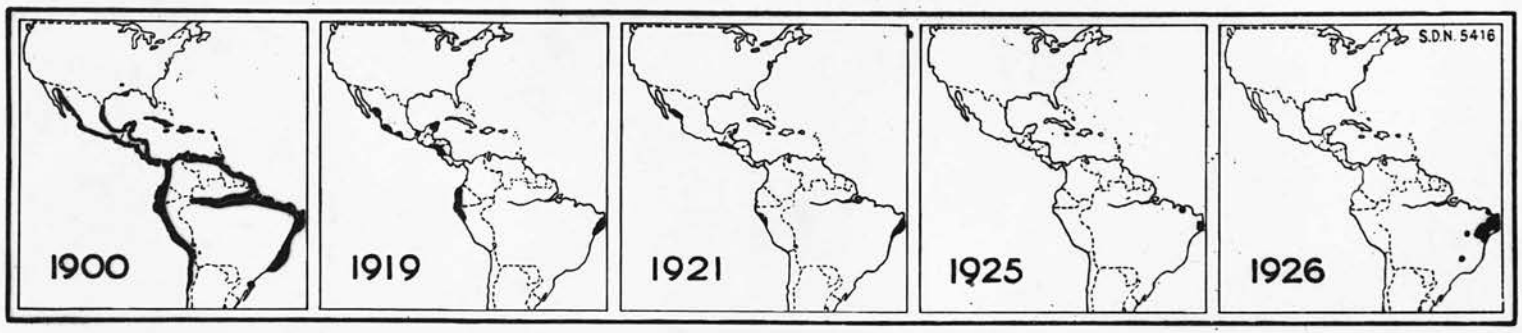
(I.1929 — IX.1935.)



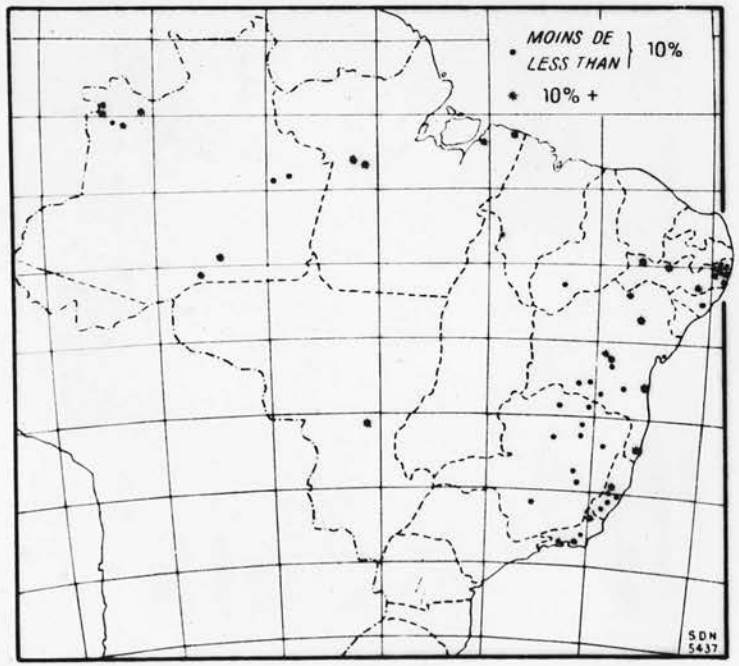
CARTE 4. — MAP 4.


A. O. F.
A. E. F.
ANGLO-EGYPTIAN
SUDAN
GUINÉE FR.
PORT.
SIERRA LEONE
LIBERIA
CÔTE D'IVOIRE
GOLD COAST
TOGO
DAHOMEY
NIGERIA
CAMEROUN
OUBANGUI-CHARI
CONGO FRANÇAIS
CONGO BELGE
ANGOLA
RHODESIA
UGANDA
TANGANYIKA
MOÇAMBIQUE
Tombouctou
Gao
Agadez
Niamey
Zinder
Sokoto
Kano
Kaya
Kayes
Tivaouane
Dakar
Sikasso
Kouroussa
Conakry
Freetown
Tamale
Kintampo
Kumasi
Bauchi
Kalaguma
Fort Lamy
Fort Archambault
Khartoum
El Fasher
El Obeid
Kosti
Malakal
Wau
Rumbek
Yubo
Juba
Addis-Ababa
Bangui
Rafai
Zemio
Abomey
Porto Novo
Lagos
Ado
Abeokuta
Lokoja
Ilorin
Ushagbo
Sekondi
Cape Coast
Accra
Cape Palmas
Gt Bassam
Douala
Libreville
Port Gentil
Coquilhatville
Stanleyville
Brazzaville
Pointe Noire
Banana
Matadi
Leopoldville
Loandа
Malangue
Benguela
Mossamedes
Dilolo
Elisabethville
Albertville
Loulouabourg
Mwanza
EPREUVES DE PROTECTION À LA FIÈVRE JAUNE
YELLOW FEVER PROTECTION TESTS
Adultes ..... Adults
Enfants ..... Children
Sérums positifs % ..... Positive sera %
Absence de tests chez adultes — No tests among adults
Absence de tests chez enfants — No tests among children
Région (total) ..... Region (total)
0 100 200 300 400 500 600 700 800 KM.
0 100 200 300 400 500 MILES
S.D.N. 5427

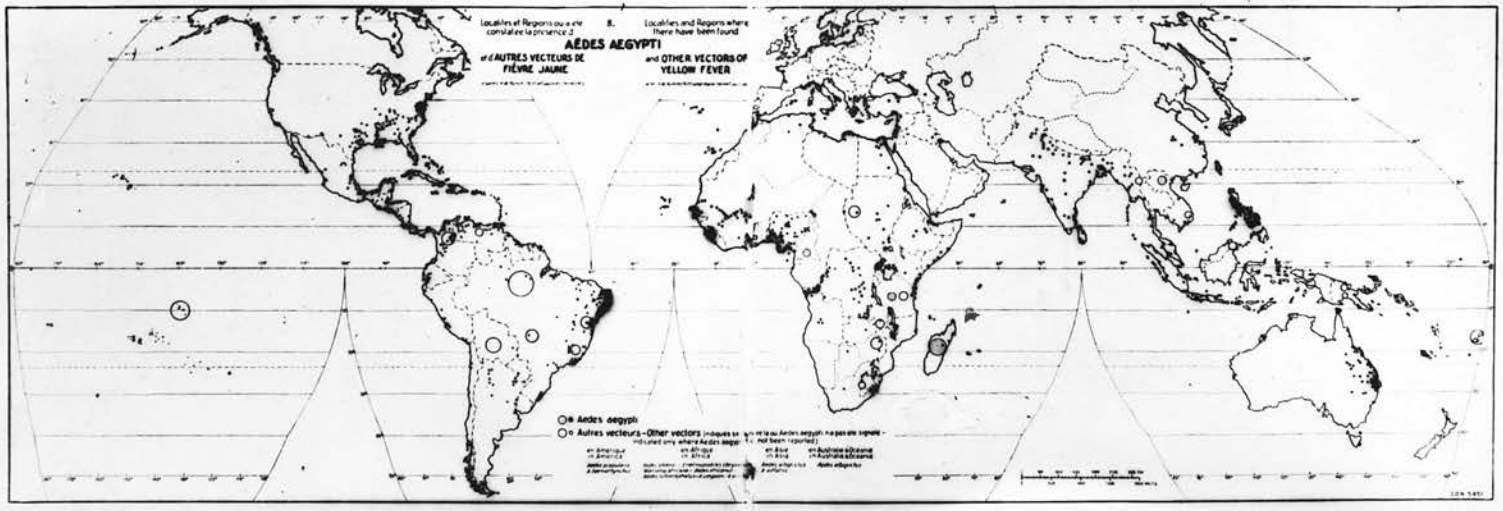
5. Régression de la fièvre jaune en Amérique d'après les rapports annuels de la Fondation Rockefeller.
5. Decline of Yellow Fever in America, according to Annual Reports of the Rockefeller Foundation.
(1900-1926)

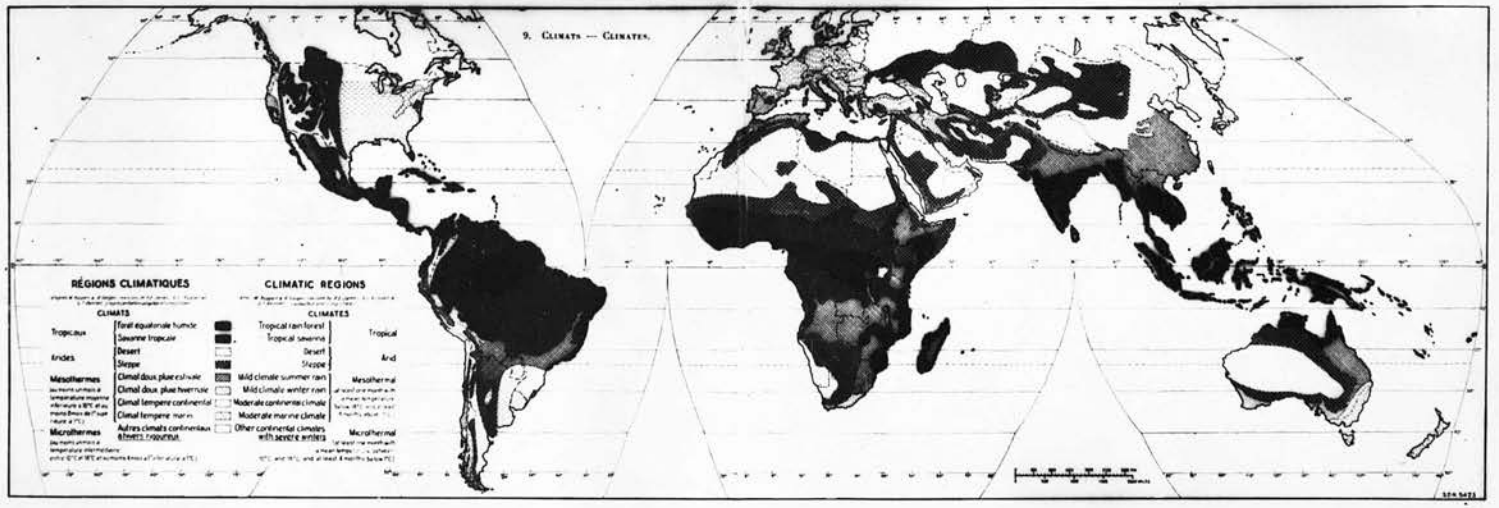


6. Tests de séroprotection positifs.
6. Positive Sero-protection Tests.



7. Viscérotomie au Brésil.
7. Viscerotomy in Brazil.


8. Localités et Régions où a été constatée la présence d'
AÉDES AEGYPTI
et d'AUTRES VECTEURS DE FIÈVRE JAUNE
8. Localities and Regions where there have been found
AEDES AEGYPTI
and OTHER VECTORS OF YELLOW FEVER
Aedes aegypti
Autres vecteurs – Other vectors

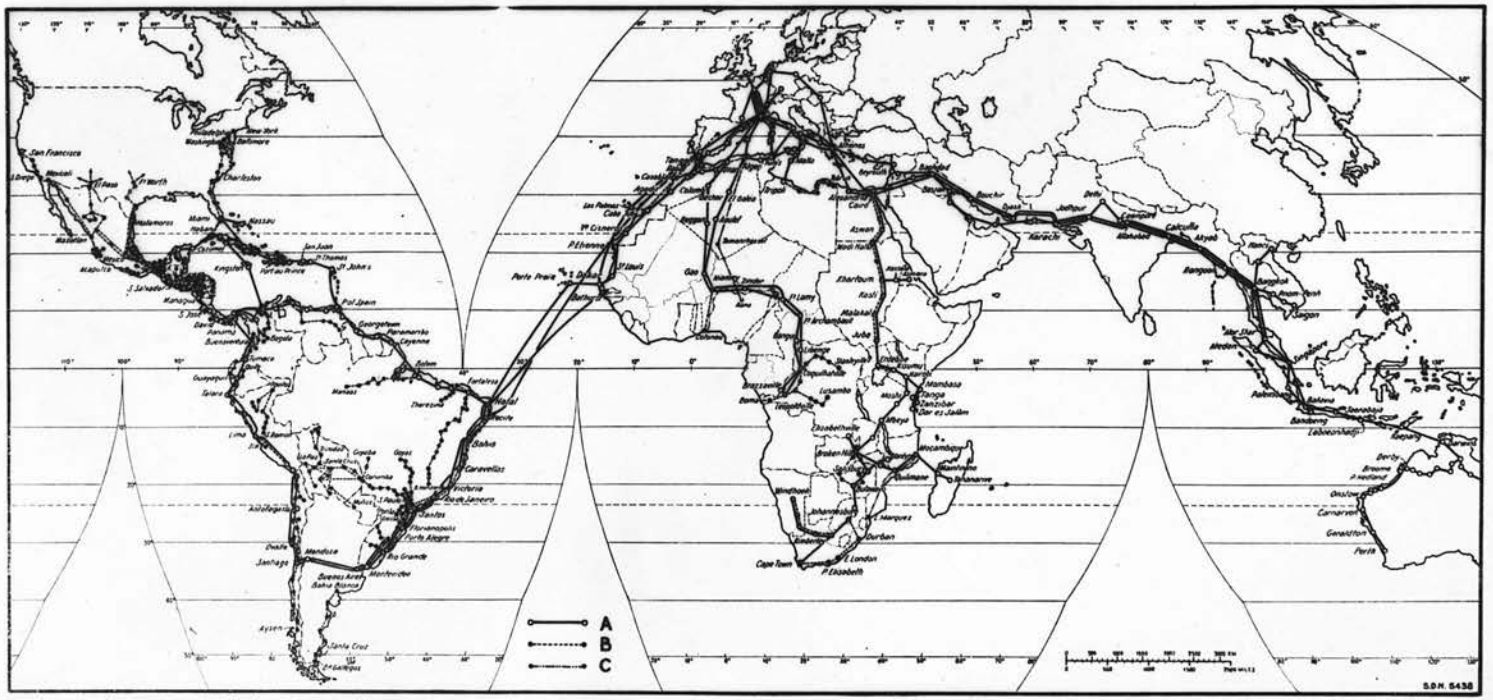

9. Climats — Climates.
RÉGIONS CLIMATIQUES
CLIMATIC REGIONS
CLIMATS
CLIMATES
Tropicaux
Tropical
Arides
Arid
Mésothermes
Mesothermal
Microthermes
Microthermal
Forêt équatoriale humide
Tropical rain forest
Savanne tropicale
Tropical savanna
Désert
Desert
Steppe
Steppe
Climat doux, pluie estivale
Mild climate, summer rain
Climat doux, pluie hivernale
Mild climate, winter rain
Climat tempéré continental
Moderate continental climate
Climat tempéré marin
Moderate marine climate
Autres climats continentaux à hivers rigoureux
Other continental climates with severe winters

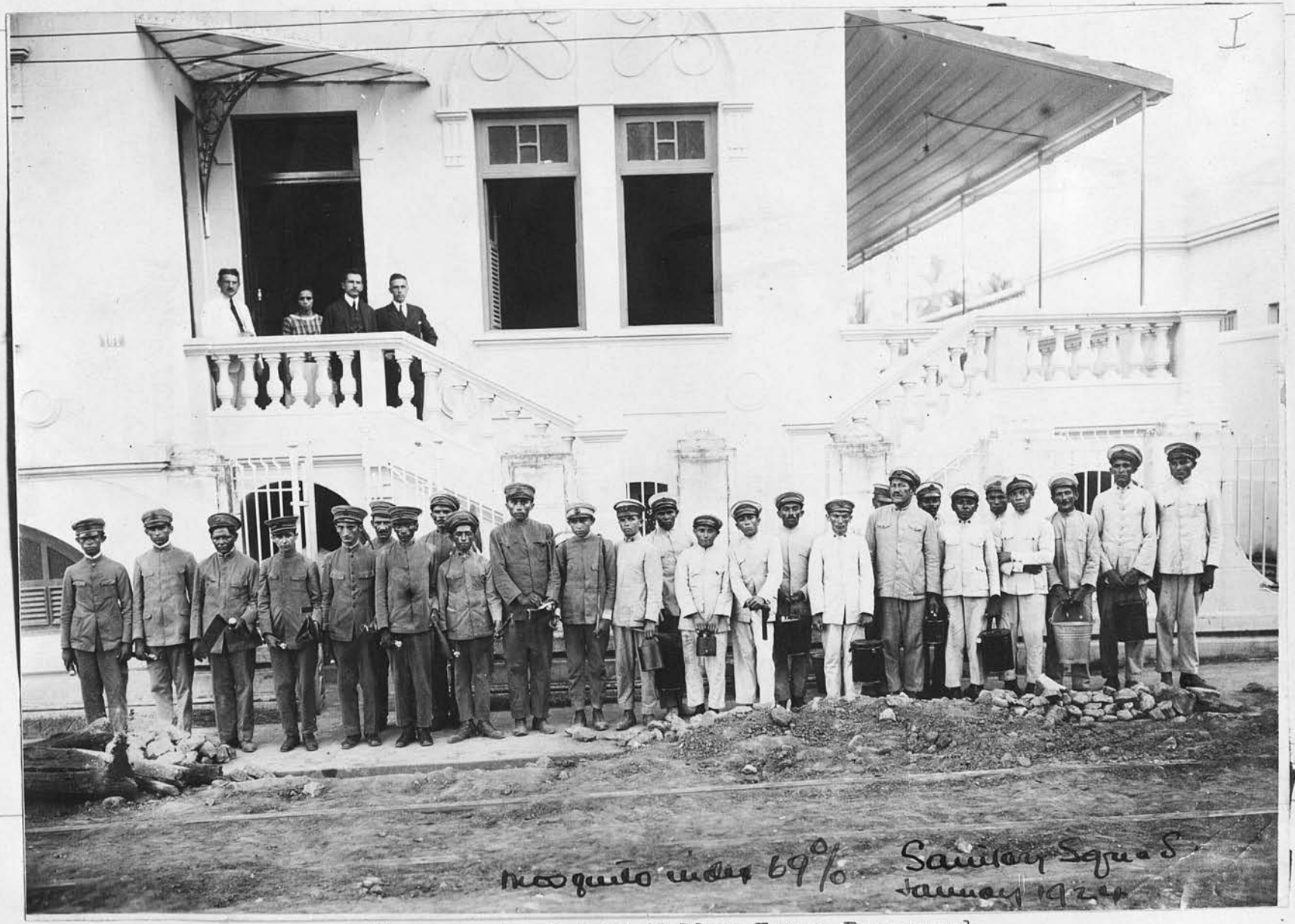
10. Lignes postales aériennes intercontinentales et Lignes internationales et internes en Afrique, en Amérique Centrale et en Amérique du Sud.

A Lignes postales internationales.
B Lignes postales internes.
C Autres lignes de passagers.

10. Intercontinental Air-Mail Lines and International and Internal Air-Mail Lines in Africa, Central and South America.

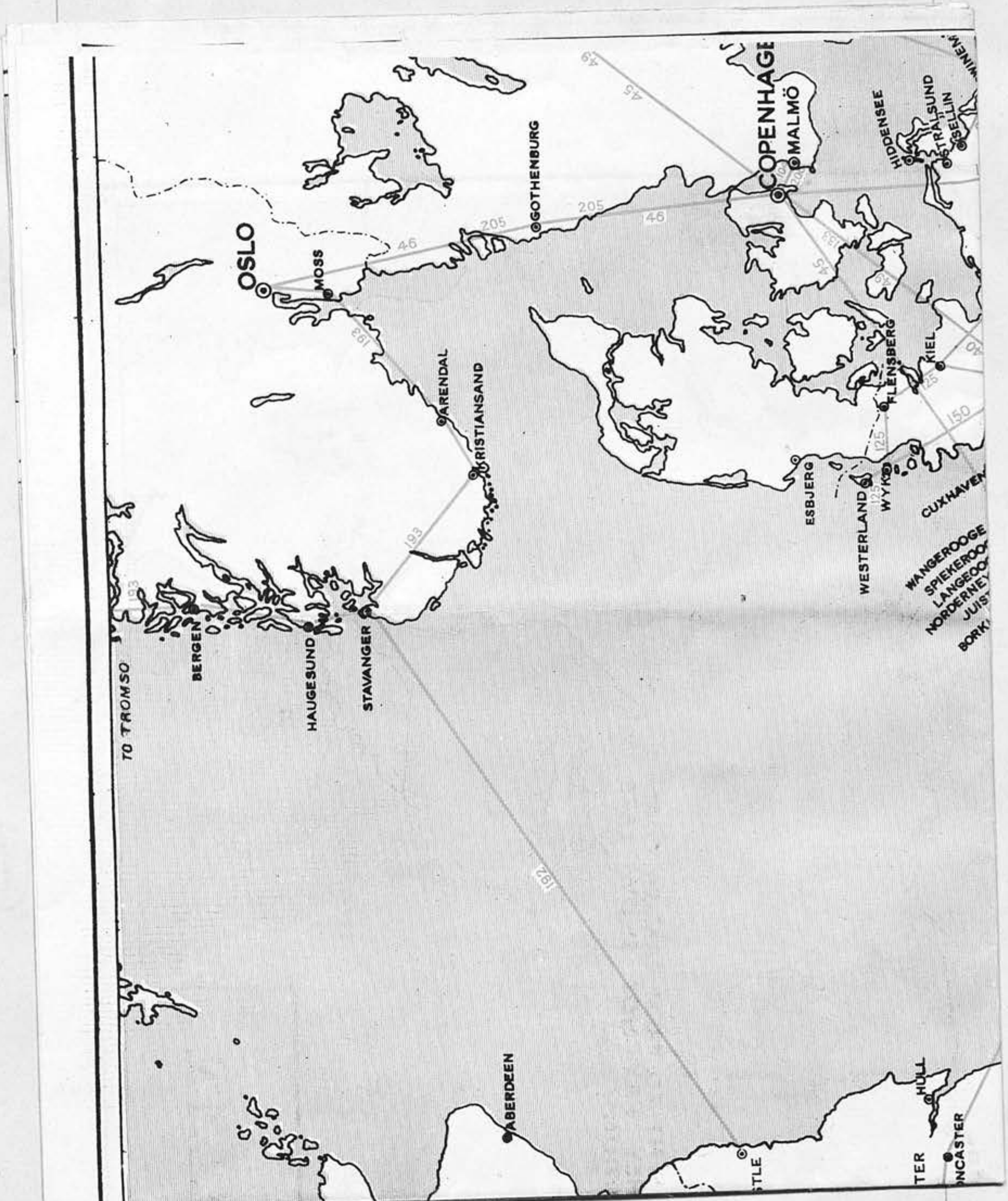
A International Air-Mail Lines.
B Internal Air-Mail Lines.
C Other Passenger Lines.



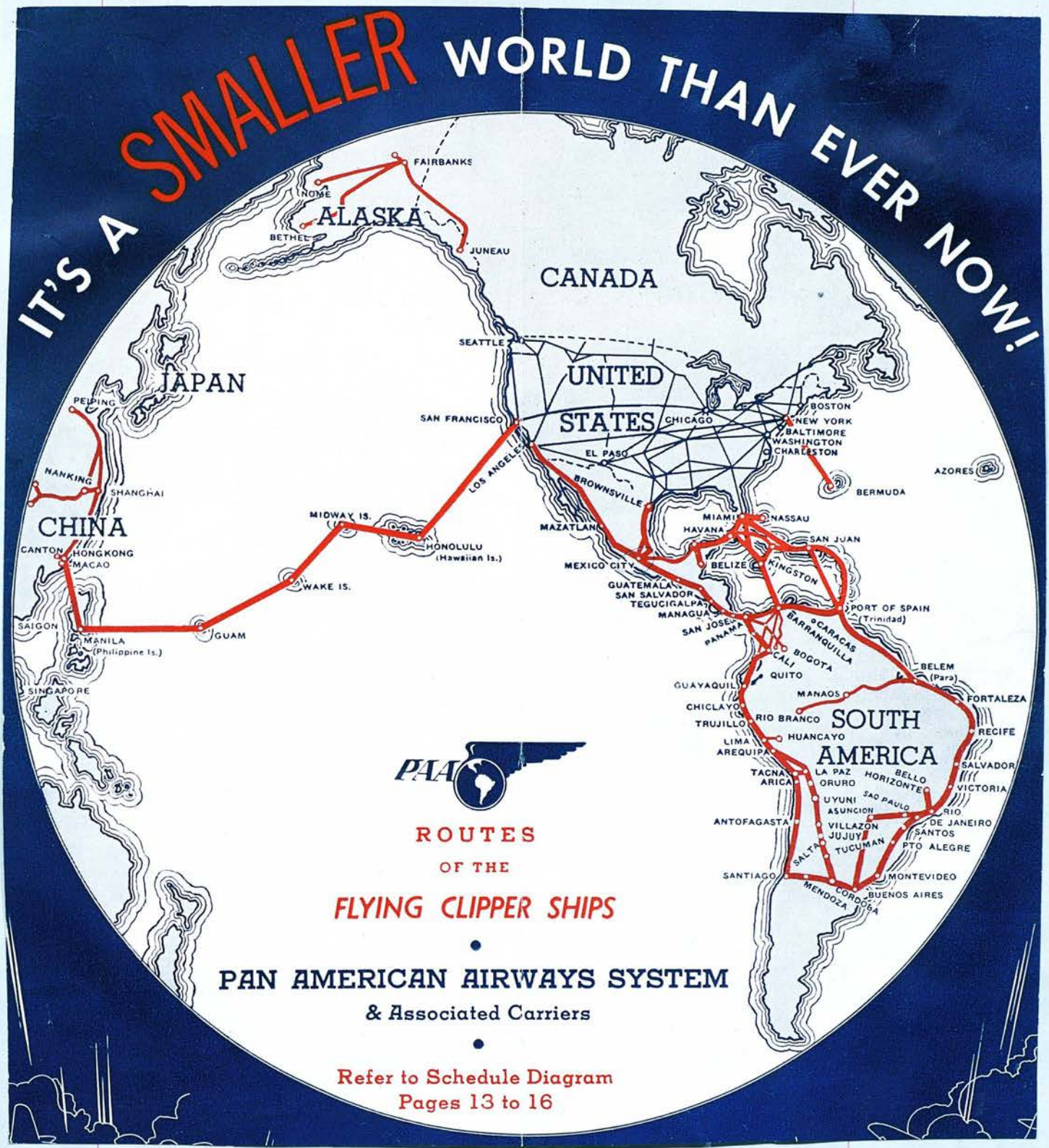


Photograph of Anti-Yellow Fever Personnel at Parahyba do Norte, Brazil, in January 1924 at the beginning of the campaign. Aedes aegypti index 69%.

Photograph of Personnel after 8 months training, Aedes aegypti index 4%. Showing Director, Fiscal, Heads of Sections, Inspectors, Assistant Inspectors, Oil men and Fishermen, with equipment.



Map showing latest extension
of Air Service to Africa and Asia.



Map showing Air Services of South and Central America. Note Caption.