AEDES AEGYPTI AS A FACTOR IN THE INTERNATIONAL SPREAD OF YELLOW FEVER

Statement presented by the Delegations of Brazil, Cuba and Panama

Epidemiologic Types of Yellow Fever

Two epidemiologic types of yellow fever are recognized:

(1) The classic aegypti-transmitted yellow fever, in which the virus is transferred from man to man by the Aëdes aegypti mosquito;

(2) Jungle yellow fever, a disease primarily of wild animals, transmitted from animal to animal, and accidentally to man, by various species of forest mosquitoes.

The etiology, symptomatology, immunology and pathology of the two types of the disease are identical, but their epidemiological picture is quite different.

The classic yellow fever is characteristically a house or household disease transmitted in the Americas by the highly domesticated Aëdes aegypti mosquito. It occurs indiscriminately among susceptible individuals living in or visiting infected houses. It tends to spread along the routes of human travel. The disease depends on the simple cycle man-aegypti-man for its maintenance and disappears after the density of the aegypti mosquito is reduced to a certain level.

Aegypti-transmitted yellow fever, which was responsible for the recognized earlier prevalence of the disease in the Caribbean Area and in South America and for the periodic seasonal excursions to North American and southern European

1 In Africa, the continent of origin of Aëdes aegypti, this mosquito occurs in forests; it has never adapted itself to the forests of the Americas.
ports, had its last endemic focus in the Americas eliminated in 1934. From 1934 to 1942 there were a few isolated minor outbreaks of aegypti-transmitted yellow fever in South America, secondary to jungle outbreaks, all occurring in towns and villages lying close to, and in intimate contact with the forests. The last such urban outbreaks to be recognized occurred in Senna Madureira, Brazil, and in Tarapoto, Peru, in 1942. Yellow fever in the Americas in the past twelve years has been limited to the jungle form of the disease.

### Epidemiology of Jungle Yellow Fever

Jungle yellow fever is not a recent adaptation in the Americas, there being references in the literature as early as the last decade of the 18th century to this form of the disease. Yellow fever outbreaks occurred as early as 1867 in eastern Bolivia in areas never invaded by aegypti. Jungle yellow fever existed and must have been widespread during the centuries when urban yellow fever was the most serious scourge of the American tropics.

Jungle yellow fever was first clearly identified in 1932, just as the campaign for the eradication of endemic aegypti-transmitted yellow fever in the Americas was coming to a successful termination. The last focus of aegypti-transmitted yellow fever in the Americas disappeared in 1934.

Jungle yellow fever in the Americas occurs in the forest in the absence of both man and Aedes aegypti. It depends on the cycle animal-mosquito-animal for its maintenance. This cycle involves primates, and possibly in some regions certain species of marsupials, and forest mosquitoes.

Jungle yellow fever in the Americas is acquired almost exclusively by direct contact with the forest. Entry into the forest or working along its edge constitutes the main hazard of contracting the disease.

2 The human case of yellow fever is rarely the source of virus for other jungle infections, since the period of acute illness is generally spent at home, out of contact with jungle vectors.
In Africa, in so far as studies have been reported, the situation is superficially different. In Uganda, yellow fever seems to be infrequently acquired by contact with the forest. *Aedes africanus*, the most important vector in the forest itself, is a crepuscular and night feeder and rarely bites man, as in general human beings do not remain in the forest at night. In the Semliki Forest area infection of man with the jungle virus is reported to occur through transmission by the semi-domestic mosquito *Aedes simpsoni*, a plant axil breeder, which becomes infected by biting monkeys along the forest edge or monkeys raiding the plantations around houses. It is not from contact with the forest that the individual is infected, but rather because of the proximity of his home to the forest and the presence of a secondary vector, *Aedes simpsoni* is not, however, an urban domestic mosquito, as is *Aedes aegypti*, and *simpsoni*-transmitted yellow fever has never been shown to be an important factor in the dissemination of the virus from place to place.

Although jungle yellow fever appears to maintain itself within certain small limited geographical areas the general picture in the Americas is one of a moving epizootic wave. This moving epizootic is apparently due to the fact that yellow fever in vertebrates is an acute self-limited infection producing a permanent immunity with no carrier state, and with the infection continuing in the vector mosquito only during the lifetime of the insect which has fed on an infected animal. Epizootic waves recur after varying intervals ranging from three to 10 years in different localities. In some localities under observation the disease has not recurred in more than 10 years following the initial observation.

The characteristic period of infectivity of a given bit of forest during these epizootic waves is limited to months, and in some cases only weeks, with an area producing infections one season almost never being dangerous the following year. Interesting observations have been made during the past five years on an epizootic wave moving from east of the Panama Canal, westward and northward through Panama, Costa Rica, Nicaragua, and into Honduras. Once the wave has passed a given point no further cases occur at this point.
The Importance of Aëdes aegypti as the Principal Factor in the International Spread of Yellow Fever

The importance of jungle yellow fever can be gauged not only by the illness and death it causes but also by its menace as a permanent potential source of virus for the infection of cities and towns infested with Aëdes aegypti. Once such cities and towns infested with aegypti become infected with yellow fever, they, in turn, become the foci for the distribution of yellow fever through the normal channels of human travel.

A most important occurrence of this kind was the infection in 1928 of Rio de Janeiro, the capital of Brazil. The re-infection of that city, after an absence of 20 years, was followed by the occurrence of cases in ships and in sea and river ports along the 4,700 mile route between Buenos Aires, on the South and Manaus, 1,000 miles up the Amazon River. During the same period 42 towns having rail connection with Rio de Janeiro were infected.

The potential threat of the movement of yellow-fever virus from regions of jungle yellow fever to receptive aegypti infested areas depends largely on the existence of aegypti infested communities contiguous to the jungle infection. In this age of rapid air transportation, aegypti-transmitted yellow fever anywhere is a serious matter, since the air passenger travelling during the period of incubation of the disease constitutes a real danger of long distance transportation of yellow fever virus.

The threat of urban yellow fever is greatest at those urban centres, infested with aegypti, most closely in contact with infected jungle districts. If Aëdes aegypti is eliminated from these points, there is little opportunity for the disease to jump long distances.

The unrecognized introduction of yellow fever into urban communities from nearby districts is the most probable mechanism by which persons preparing to travel to other countries might be infected close to the date of departure. This danger largely disappears with the eradication of Aëdes aegypti.

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3 Yellow fever has a tendency to spread slowly when introduced in a locality, even if the conditions are favourable for its diffusion. When the first cases are diagnosed, the disease is already well established.
This was well illustrated by the fact that during the epidemic which for seven years, 1934 to 1940, spread to nine southern states of Brazil, to Paraguay, and to the Misiones Province of Argentina, only four infective cases of yellow fever are known to have reached Rio de Janeiro, and these came at the height of the 1938 season when yellow fever virus was literally at the door of Brazil's capital. Although thousands of cases occurred within 250 miles of Rio de Janeiro, no infective cases, nor cases in incubation, are known to have gone through the capital en route to other cities, nor to have moved internationally. No infective cases were observed in Rio de Janeiro in 1935, when jungle yellow fever reached the area served by railroad connections to Rio de Janeiro, nor in 1936 or 1937, as the disease advanced towards the city, nor in 1939 or 1940 as the epizootic moved north-eastward, away from Rio de Janeiro.

This is in sharp contrast with what happened in 1928-1929, as cited above, when the aegypti index was high in Rio de Janeiro and that city was functioning as a way-station for the multiplication and exportation of yellow fever virus.

In spite of important human outbreaks of jungle yellow fever since 1942 in Venezuela, Colombia, Ecuador, Peru, Bolivia, Brazil, Panama, Costa Rica and Nicaragua, no cases of aegypti-transmitted yellow fever have been observed in the Americas during these past twelve years, nor have any cases of yellow fever moved through international travel routes.

Jungle yellow fever tends to spread entirely independently of human travel routes, through contiguous, or nearby contiguous, forest areas. In this way the disease moved internationally from Brazil to Paraguay and into Argentina in 1937-1938, and again in 1947-1948; from Panama to Costa Rica and into Nicaragua in 1951; and from Nicaragua to Honduras in 1953. Neither humans nor the Aedes aegypti mosquito have had a part in these movements.

Man has not been observed to carry jungle yellow fever virus far from the point of infection and, in the absence of aegypti-transmitted yellow fever, man has not represented an important threat to international traffic. On the other hand, yellow fever in a port city in the presence of a high aegypti index, easily makes man a dangerous carrier of the virus.
The historical recession of yellow fever as an international threat, subsequent to the anti-aegypti campaigns carried out after 1900, is significant. There is no reason to believe that the first three decades of this century were any less favourable for the occurrence of jungle yellow fever than have been the 20 years since observations on this disease have been made. Relatively limited campaigns against the aegypti mosquito during the period before the recognition of jungle yellow fever so reduced the incidence of recognized yellow fever and so far prevented the international spread of yellow fever that public health workers were convinced in 1927 that eradication of the disease in the Americas was imminent or had already occurred. Such results would have been impossible if jungle yellow fever were an important source of infection for towns far from jungle areas. The eradication of Aedes aegypti from all urban centres close to jungle yellow fever areas is the most important measure which can be taken for the protection not only of these centres themselves but of aegypti infested centres in other parts of the world. Administratively, it is more economical to eradicate Aedes aegypti than to maintain permanent campaigns against this mosquito. The programme for the complete eradication of aegypti is well advanced in South and Central America and has begun in Mexico, Cuba, Haiti, the Dominican Republic, and in many Caribbean areas. The continental campaign for the eradication of the aegypti mosquito throughout the Americas has as its objective the prevention of the re-infestation of centres close to jungle areas, which is of importance to every country in the Americas.

The Pan American Sanitary Bureau has been publishing for many years the aegypti indices of the principal ports and cities of its Member States, since it is believed to be more important to know the aegypti density of a port city as an indication of its potential threat as a source of yellow fever than it is to know whether jungle yellow fever has been reported or not in the nearby areas.