New entomological and virological data on the vectors of sylvatic yellow fever in Brazil

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The present report focuses on recent ecoepidemiological data on yellow fever, obtained recently in two very distinct ecoepidemiological contexts: the Barcarena (PA) area, situated in the dense Amazonian rain forest, and the Campo Grande (MS) region, situated in the cerrado with gallery forest in central Brazil. In the first region, one strain was isolated from a pool of 6 Haemagogus janthinomys. In the other region, 2,480 anthropophilous mosquitoes were collected, of which near 40% were potential YF vectors. These species, classified by decreasing relative abundance, were: Aedes scapularis, Sabethes chloropterus, Hg. janthinomys, Hg. leucocelaenus, Hg. spengazzini, and Sa. soperi. Four strains of YF virus were isolated from Hg. janthinomys, one from Sa. cheiropterus (first report for South America) and one from Sa. soperi (first report). The minimal infection rates varied among the three localities of collection but were all high, compared with previous data. The mean daily survival rate was 0.9635 for the populations of Hg. janthinomys, allowing extrapolation of the value of the infection rate when people were infected most recently. It was deduced that the epizootics were intense and more or less concomitant in the three areas. The main problem that remained to be solved concerns the mode(s) of reintroduction or survival of YF virus in each of the two regions under study.

O presente trabalho enfatiza resultados recentes sobre eco-epidemiologia da febre amarela, obtidos em duas localidades ecológicamente muito diferentes: Barcarena (PA), situada na floresta amazônica densa, e a região de Campo Grande (MS), coberta de cerrado atravessado por florestas de galeria na região Cerrado-Várzea. No primeiro local foi isolada uma amostra a partir de um lote de 6 Haemagogus janthinomys. Na região de Campo Grande, 2.480 mosquitos antropófagos foram colecionados, dos quais cerca de 40% eram vetores potenciais do FA. Essas espécies, classificadas por ordem decrecente de abundância, eram: Ae. scapularis, Sa. chloropterus, Hg. janthinomys, Hg. leucocelaenus, Hg. spengazzini e Sa. soperi. Quatro amostras de FA foram isoladas a partir de Hg. janthinomys, uma de Sa. chloropterus (primeiro registro na América do Sul), e uma de Sa. soperi (primeiro registro). As taxas mínimas de infecção variaram segundo os locais de coleta, mas foram sempre altas em comparação com dados anteriores. A taxa média de sobrevivência diária do Hg. janthinomys é igual a 0.9635, permitindo estimar o seu valor no ocaso em que os casos humanos mais recentes foram provavelmente contaminados. Deduz-se que as epizootias foram muito intensas e mais ou menos simultâneas nos dois locais considerados. O maior problema a ser resolvido é o modo de reintrodução do vírus, ou sua sobrevivência, em cada região sob estudo.

Despite the existence of a good vaccine, yellow fever (YF) virus continues to cause, almost every year many human deaths in its area of distribution (1). The reasons of the failure to control this disease are multiple. The main reason is related to the difficulty of accessing and vaccinating all people in the risk regions. Another reason is the lack of the ecological data which would be needed for establishing vaccination priorities. In other words, it would be necessary to better understand the mechanisms of i) the transmission of the virus and ii) emergence of epizootics, with or without human cases,

in order to define the places and times where and when the risk of transmission is highest.

Recent studies in Africa (2,3) and South America (4) have shown that diverse ecoepidemiological situations may exist, which are characterized by the nature of man-made changes of the environment and vector populations. Further, it became evident that the studies in Brazil must be related to the phyogeographical zones present in the country (1). The present report will focus on data, obtained recently in two very distinct ecoepidemiological contexts, with a discussion of implications for future studies.

The three main phyogeographical zones where YF virus is circulating in Brazil are characterized by dense Amazonian rain forest, open rain forest and gallery forests run-
Isolation of YF virus in the absence of human cases

During routine mosquito collecting work, done in Barcarena, Pará (Figs. 1 to 4) (6), from June 12 to 26, 1991, one strain of YF virus was isolated from the six mosquitoes which constituted the only inoculated pool of *Ha. janthinomys*. Such a high infection rate (16.66%), associated with a very low relative density (0.3 mosquitoes/man X hour), is probably the result of a high sampling error. The only other potential vectors which were also collected were *Ae. scapularis* (1 specimen), *Hg. leucocelaenus* (4 spec.) and *Sa. chloropterus* (23 spec.; 1 pool) (7).

Two studies, conducted in the same region, from June 21 to 28 and September 20 to 28, 1990, gave mainly the same entomological pattern (8). More recently, no strains were isolated on a collecting trip, made between December 3 and 21, 1991 (9).

In order to identify the possible incidence of YF in the human population (by sylvatic contacts or vaccination), four serological surveys were done, the positive results of which are reported in Table 1 (10).

Unexpectedly, antibody rates to YF virus were not high among the riverine populations in this region. This may be due either to a low rate of vaccination or to a lack of contacts between man and sylvatic YF virus, or both. On the other hand, high immunity rates against Mayaro virus, which is transmitted mainly by *Hg. janthinomys* (11), show that the contacts with the vectors actually exist or have existed. In fact, the active circulation of YF virus was detected in this region or the nearby Abaetetuba county only in 1968 (12) and 1988 (13). YF virus may have circulated...
at a very low rate, and only among the monkey population which is probably diffuse. However, we consider that there is a real risk of sporadic human cases that could occur or even an epidemic to initiate if the simian population increases.

**Isolation of the YF virus during an epidemic with many human cases**

At the end of 1991 and beginning of 1992, a total of 14 human YF cases were confirmed in the region of Campo Grande (MS). This region is phytoclimatically very dif-

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Table 1 — HI positive human sera and rates of arboviruses in the region of Barcarena, Para, according to year of survey.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Yellow fever (sylvatic)</td>
<td>21</td>
<td>18.7</td>
<td>1</td>
<td>0.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Yellow fever (vaccinal)</td>
<td>14</td>
<td>13.3</td>
<td>14</td>
<td>5.5</td>
<td>4.4</td>
</tr>
<tr>
<td>Ibania</td>
<td>3</td>
<td>2.6</td>
<td>30</td>
<td>29.7</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>6.7</td>
<td>58</td>
<td>7.6</td>
<td>53.3</td>
</tr>
<tr>
<td>Saint Louis encephalitis</td>
<td>4</td>
<td>3.6</td>
<td>4</td>
<td>3.9</td>
<td>4.6</td>
</tr>
<tr>
<td>Western equine encephalitis</td>
<td>2</td>
<td>1.9</td>
<td>2</td>
<td>0.8</td>
<td>3.7</td>
</tr>
<tr>
<td>Mayaro</td>
<td>16</td>
<td>15.8</td>
<td>19</td>
<td>18.1</td>
<td>35.9</td>
</tr>
<tr>
<td>Mimonho</td>
<td>3</td>
<td>3</td>
<td>10</td>
<td>7.6</td>
<td>13.1</td>
</tr>
<tr>
<td>Campauculo</td>
<td>2</td>
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<td>2</td>
<td>1.9</td>
<td>4.2</td>
</tr>
<tr>
<td>Canu</td>
<td>12</td>
<td>11.4</td>
<td>12</td>
<td>12</td>
<td>12.1</td>
</tr>
<tr>
<td>Quaro</td>
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<td>1.9</td>
<td>1</td>
<td>0.9</td>
<td>3.8</td>
</tr>
<tr>
<td>Maguari</td>
<td>7</td>
<td>6.6</td>
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<td>2.8</td>
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<tr>
<td>Icoraci</td>
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<td>1.3</td>
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</tr>
<tr>
<td>Taparana</td>
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<td>6.6</td>
<td>2</td>
<td>6.6</td>
<td>8.8</td>
</tr>
</tbody>
</table>

* Due to lack of homogeneity between the 1968 survey and the following surveys, the results of the former have not been included in these figures.

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Figure 5. Map of Mato Grosso do Sul State with divisions of counties, localization and year of report of cases of YF during the last 39 years.
15. Field collecting of mosquitoes was done between January 24 and February 10, between January 26 and February 5, and from Febru-
ary 6 to 14 in the three ranches, Fazendas Cabecinha do Jaguari, Rincola and Aguas Encantadas, respectively.

16. Other authors are considering this species as only a "possible poten-
tial vector" and not a "proven potential vector", because it has never been 
encountered naturally infected by YF virus.

Aedes argyurus (L.); importância de sua biologia na transmissi-
dade da Dengue e dos outros arbovírus. Propomente parte. 
Boll Soc Paul 8: 97-110. 10em Deuxième partie: 111-124

18. The mean daily survival rate may be estimated when the duration of 
the gonotrophic cycle and the parasite rate of the population are 
known. The ovaries of the mosquitoes were dissected, left to dry at 
room temperature, and examined under the microscope. Their 
nulliparous state is inferred from the presence/absence of 
coiled tracheoles.

19. Hg. (Hapalocera) xenomosy: Siderolândia, 3 strains, Campo 
Grande, 1 strain, Ss. (Sahbotes) chloroperae: Siderolândia, 1 
strain; Ss. (Sahbotes) superi, Jaguariúna, 1 strain

20. The very high infection rate is probably due to a sampling error as 
was the case for the strain isolated from Barcarena.

certain other viruses of vertebrates, 3rd ed, American Society of 
Tropical Medicine and Hygiene, San Antonio, Texas


no Brasil. Rev Fund SESP 28: 11-19

24. Rawlins SC, B. Hull, DD Chade, R. Martinez, A. LeMaitre, F. James, L 
Trans R Soc trop Med Hyg 84: 142-143

25. Strains of YF virus have been isolated by the IEC once from a pool of 
unidentified Sahbotes mosquitoes and once from a pool of 
Aedes sp. and Sabethes sp.

26. Galindo P 1958 Biomics of Sahbotes chloroperae Humboldt, a 
Hyg 7: 429-440

27. Dégâljer et al, unpublished data

28. The mean relative density and infection rate are 3.1 mosq/man h 
and 0.21% (35/16,573), respectively

29. We were able to see remains of dead Howler monkeys (Alouatta 
caraya) in the Jaguariúna and Siderolândia counties (Fig.

30. A mean incubation period of five days is assumed (see note no. 4)

31. In the Jaguariúna county no strain was isolated from Hg. 
janthonomys 52 days after the time the last human patient was 
serologically infected. As the sensibility of sucking mice is sufficient 
to allow isol-
ation at very low rates (around 0.016%), it is reasonable to consider 
that the YF virus has vanished from the adult population of this 
species, at this time

32. From the virus point of view!

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