Antigenic variation among arboviruses

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Arthropod-borne viruses are relatively stable in their antigenic properties. According to Clarke¹, isolations of Yellow fever in the same locality 20 years apart were indistinguishable in their properties. On the other hand, several examples have recently come to light of variation in antigenic properties of virus strains believed to be the same virus.

Yellow fever is a classic example. One of the participants today, dr. Manoel Bruno Lobo, was the first to note a difference in the results of hemagglutination-inhibition test results with the south american JSS strain as compared with the african Asibi, the french, or the 17-D vaccine strains of Yellow fever virus. He communicated his findings to dr. Delphine Clarke, and her follow-up experiments¹ with antibody absorption indicated that the JSS strain was deficient antigenically when compared to three african Yellow fever strains. In addition, she showed that two other south american strains were similar to the JSS strain and also different from the african strains. Thus it appeared that there was antigenic variation between african and south american Yellow fever and that the variation depended on the geographical site of original recovery.

Also, dr. Clarke¹ compared the 17-D vaccine strain by antibody absorption technique with the parent Asibi strain and showed that 17-D had gained an antigenic component. The assumption is that the 17-D strain represented the result of a mutation of the Asibi virus brought about by passage in chicken embryo cultures.

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Another recently observed example of antigenic variation is that by Karabatsos and his co-workers with Western Equine Encephalitis (WEE) virus strains. They showed considerable antigenic difference by hemagglutination-inhibition, complement fixation, and neutralization testing between four strains from Western North America on the one hand, and three strains from Eastern North American on the other. Dr. Jack Henderson has followed up these findings using an ingenious technique involving chicken embryo tissue culture under agar. He has selected different virus populations of WEE strains from Eastern and Western North America by choosing plaques, and has analyzed these populations in neutralization tests. The WEE strains are composed of heterogeneous populations, and the serological reaction seems to depend on the proportion of each different population type in a given strain. In general, most of the strains from Western North America are similar, and most from Eastern North America are similar. In addition, he has shown in some strains that passage in avian tissues maintains the stability of the population proportions, whereas passage in mice changes this stability. In essence, the vertebrate host selects the population which will be dominant.

The group C viruses have only been found in the tropical regions of South and Central America. Of seven known types, Caraparu is the most widely encountered to date. Some studies carried out at the Belém Virus Laboratory indicate that variation among Caraparu strains also depends on the geographic site of isolation. Early studies indicated that 205 group C strains were of seven types by complement fixation and hemagglutination-inhibition testing, and that there was little if any variation of Belém strains within the types. Recently, we have had an opportunity to compare Belém Caraparu types with closely related strains from Trinidad and Panama. Testing was done by hemagglutination-inhibition testing. The results are shown in the first table expressed as the number of two fold dilutions of inhibition starting at 1:10. The five strains from Belém were isolated between 1956 and 1963 from sentinel mice, sentinel monkey and human sources. As can be seen by following the columns marked 1, 2, 3, 4 and 5 downward, the
serum titers with Belém antigens did not vary more than two dilutions whereas with Trinidad and Panama antigens the titer in all but one case is three or more dilutions less than the homologous. It is also clear that the Trinidad and Panama strains differ significantly from each other.

Table 1 – Comparison of Caraparu strains originating in Belém, Trinidad, and Panama by hemagglutination-inhibition testing

I have used the examples of Yellow fever, a group B arbovirus; WEE, a group A virus; and Caraparu, a group C virus, to illustrate the phenomenon of antigenic variation in the arthropod-borne virus family. Three aspects are brought out. Firstly, the viruses are antigenically stable in nature in a given geographical area, but if one moves to another continent or even to a different site on the same continent, the naturally encountered virus strains vary. Secondly, at least with WEE, the strains are made up of an antigenically heterogeneous population, the proportions of which may be changed by passaging in an unnatural host; and thirdly, mutations may occur as has been demonstrated with Yellow fever 17-D strain, changing the antigenic make-up of the virus. This latter phenomenon is probably rarely successful in nature.

It is interesting to speculate on the reasons for, and significance of the geographical variations. Reasoning by analogy with WEE, perhaps arthropod-borne virus strains vary from place to place because in different geographical locations they encounter different host species and different vector species which determine the antigenic...
population making up the predominant serological type in a given locality. This hypothesis would also explain the antigenic stability over the years in a given location like Belém where the vertebrate and mosquito population are relatively stable.

To test the hypothesis it has been proposed to artificially infect the natural vertebrate host of Belém with a strain of virus from Trinidad or Central America and try to reproduce the Belém mosquito-vertebrate cycle, to see whether the predicted antigenic variation could be induced. Unfortunately this experiment must wait, since as yet we do not know for certain what the host and vector for Caraparu is in any of its natural habitats.

SUMMARY

Antigenic variation is described among Caraparu virus strains originating in geographically separated regions of South and Central America. Five Caraparu strains originating in Belém, Pará, Brazil are very closely related in hemagglutination-inhibition testing. These Brazilian strains can be differentiated from strains isolated outside of Brazil. Similar variation has been described previously with Yellow fever and Western Equine Encephalitis viruses.

It is suggested that perhaps arthropod-borne virus strains vary from place to place because in different geographical locations they encounter different host species and different vector species which determine the antigenic population making up the predominant serological type in a given locality.

REFERENCES


5. JONKERS, A. H. and others – Laboratory studies with wild rodents and viruses native to Trinidad. Part II: Studies with the Trinidad Caraparu-like agents TRVL 34053-1. In preparation.