Antigenic Properties of Tickborne Viruses: Present State of Knowledge

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It is becoming increasingly difficult, even for the specialist, to keep track of the number of distinct arboviruses recognized. At least 250 have now been reported. Between 60 and 80 are known to infect man, either in nature or through accidental laboratory exposure. From 20 to 25 of these are responsible for human diseases of major importance, as measured by severity of symptoms or number of individuals attacked, or both. A few others are of major veterinary importance.

Arthropods known to serve as vectors of arboviruses belong to 4, possibly 5, taxonomic groups: mosquitoes (Diptera: Culicidae), ticks (Acarina: Ixodidae and Argasidae), sand flies (Diptera: Psychodidae: Phlebotominae), biting midges (Diptera: Ceratopogonidae: *Culicoides*), and possibly mites (Acarina).

Among the properties of arboviruses, their antigenic characteristics have received particular attention. Sets of arboviruses have antigens in common, which means that the viruses within a set cross-react in serologic tests; as a consequence, antigenic groups emerge. At present, there are from 26 to 28 such groups, which range from as few as 2 members to as many as 35 or 36 and altogether comprise 160–170 grouped viruses. The other arboviruses are still ungrouped and may, or may not, remain so.

Tickborne viruses, viruses whose vectors are ticks, can be arbitrarily divided into 2 sets, those that belong in antigenic group B and those that do not belong in group B. As the former have generally been studied extensively and are amply described, this paper will deal mainly with the tickborne viruses outside group B.

TICKBORNE VIRUSES OF GROUP B

The tickborne viruses of group B constitute a subgroup or complex in that, with a single exception (Kadam virus), they are antigenically more closely related among themselves than they are to the other members of group B. At present, there are 8 of these viruses:

1. Tickborne encephalitis virus, represented by 2 subtypes: the Far Eastern subtype, which is responsible for a serious illness of man known as Russian spring-summer encephalitis or Far Eastern encephalitis; and the Central European subtype, which causes a milder disease, usually a diphasic, febrile meningoencephalitis.
2. Louping ill virus, responsible for a disease among sheep in Scotland and northern England.
3. Omsk hemorrhagic fever virus (also with 2 antigenic subtypes), the cause of one of the several severe hemorrhagic fevers of man.
4. Kyasanur forest disease (KFD) virus, the cause of a severe, often fatal, disease of man in India.
5. Powassan virus, the North American member of the complex.
6. Negishi virus, isolated from 2 fatal infections in man in Japan.
7. Langat virus, first isolated in Malaya.
8. Kadam virus, recently isolated in eastern Africa by the staff of the East African Virus Research Institute, Entebbe, Uganda, and at present of undetermined pathogenic potential.

For all these agents, with the exception of Negishi virus which has been isolated only from man, the known or presumed vectors are hard ticks (Ixodidae). The genera principally involved are *Ixodes* for tickborne encephalitis, louping ill, Langat, and Powassan viruses; *Dermacentor* for Omsk hemorrhagic fever and Powassan viruses; *Haemaphysalis* for KFD virus; and *Rhipicephalus* for Kadam virus.

While these viruses, being part of group B, are all antigenically related to mosquitoborne viruses, the situation of the nongroup B tickborne viruses is quite different.

TICKBORNE VIRUSES NOT OF GROUP B

The tickborne viruses not of group B form an increasingly large collection that at present numbers close to 40 serotypes. None is antigenically related to arboviruses outside the collection. However, some are related among themselves and at least 7 true antigenic groups, comprising 21 viruses, are recognized. The remaining viruses in the collection are ungrouped.

As with other arboviruses, evidence of an arthropod vector, a tick in this instance, is conclusive in the case of only a few of these agents. Colorado tick fever (CTF) virus is 1 example. The majority are considered to be tickborne on the basis that ticks are the only arthropods from which they have been isolated in nature, but even this rule has its exceptions, as will be seen later.

The tick genera from which these viruses have been isolated are listed in Tables 1 and 2, divided into soft ticks (Argasidae) and hard ticks (Ixodidae). While these tables represent an attempt to summarize all available data, they may not necessarily be complete, since the arbovirus field is one of active research, with new facts constantly emerging.