Worldwide Research on Human and Animal Diseases Caused by Tickborne Viruses

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The ecological grouping known as tickborne viruses was first reviewed by Smith (1962), who listed 13 entities. The ensuing 6 years have seen this number expanded to about 50. The exponential rate of discovery or recognition of these viruses has been amply illustrated in the preceding paper (Casals 1970). Sixteen of the 48 viruses discussed by Dr. Casals are too new to have been included in the recent Catalog of Arthropod-Borne Viruses of the World (Taylor 1967). Hoogstraal (1966) reviewed tickborne viruses causing human disease and cited other reviews. In the present paper no attempt at complete coverage is made. Instead, I have selected for discussion certain significant trends and accomplishments since Hoogstraal's compilation, except those in Russian spring-summer encephalitis, and in Omsk, Crimean, and Central Asian (=Uzbekistan) hemorrhagic fevers (OHF, CHF, and CAHF). The status of these hemorrhagic fevers was recently reviewed by Casals et al. (1966) and a few minutes ago Dr. Casals gave us the momentous news that at long last the viral agent of CHF had been conclusively isolated and found to be identical to other viral strains previously recovered from ticks, domestic and wild animals, human beings, and biting midges in Africa and West Pakistan. Owing to this diversity of distribution, hosts, and ecology of CHF virus, Casals and Hoogstraal (personal communication) believe that when CAHF virus is isolated and compared, it may prove to be identical to CHF virus.

There appear to be no very recent advances in knowledge of Kumlinge virus of Finland and Negishi virus of Japan, both infectious for humans and related to Central European tickborne virus, or of Nairobi sheep disease, which is infectious for livestock and man.

TICKBORNE VIRUSES OF THE "B" GROUP

In Great Britain, *louping ill* (LI) is primarily a disease of sheep and is transmitted by *Ixodes ricinus* (L.). Contrary to the related tickborne encephalitis virus of Central Europe, LI virus can produce severe symptoms in man and animals; it is often fatal to sheep and cattle. The London School of Tropical Medicine and Hygiene continues its study of the ecology of LI on sheep farms in Ayrshire (Varma and Page 1966). Laboratory studies at the Wellcome Research Laboratory, Beckwith, done in collaboration with the Microbiological Research Establishment, Porton, are relating the significance of antibody persistence to epizootics of LI (O'Reilly et al. 1968). A comparison of methods for measuring neutralizing (NT) and hemagglutinin-inhibition (HI) antibodies has demonstrated that whereas the former are more suitable as indicators of long-past infections, the latter best demonstrate recent virus activity.

In Ireland, presence of LI virus (although previously clinically evident) has been confirmed by isolation from sentinel sheep and *I. ricinus* (Walton and Kennedy 1966). In Britain LI is primarily an upland disease, but in Ireland it is found also in the lowlands, where it infects humans, cattle, and sheep. Workers at the University of Cork are studying the distribution and ecology of LI virus and its vector. Factors that may meliorate existence of the virus in the lowlands are canopy and other vegetational features that support small vertebrate hosts of *I. ricinus,* and more humid ambient and microenvironmental conditions. The latter conditions are undoubtedly affected by a more dispersed rainfall throughout the summer, which is reflected by longer seasonal activity of ticks. Land reclamation and drainage may tend to reduce the association among LI, man, and cattle when the virus, vector, and small hosts become restricted to less accessible areas (Walton 1967).

Tickborne encephalitis (TE) of Europe meets or merges at its easternmost limits with RSSE, which ranges from Eastern Europe to the Pacific Ocean. Although antigenically related, the two are distinct serologically, ecologically, and epidemiologically. Their vast geographical distribution and impact on human health have stimulated study by numerous European and Soviet laboratories, noteworthy among which are the Institute of Virology of the Czechoslovak Academy of Sciences at Bratislava and The Institute of Poliomyelitis and Viral Encephalitis at Moscow.

Approaches in both Czechoslovakia and USSR have been based on the premise that a profound knowledge of the factors governing virus circulation in nature is necessary for effective control of the disease in man. This philosophy is amply demonstrated in a recent monograph on TE by Blaščovič and others (1967), in which is reported results of studies of flora, bird hosts of ticks, tick and mammalian autecology, and tick-virus synecology, and of virological, serological, epizootological, and epidemiological surveys. Recent ecological investigations and laboratory studies have implicated hedgehogs, shrews, and moles as significant reservoirs of TE virus (Kozůch et al. 1965, 1967a; Nosek and Grulich 1967). These implications are supported by virus isolations and serologi-