REVIEW ARTICLE

VIRUS DISEASES OF DOMESTIC ANIMALS

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This is the first of a series of short review articles concerned with viral diseases of domestic animals. Further reviews in this series will deal with specific diseases of the various species of domestic animals, while the present article will consider some recent concepts of the nature of viruses, and of the diseases they cause.

Classification and Nomenclature

Viruses, it is now agreed, are unique agents differing fundamentally from micro-organisms such as bacteria and protozoa. The characters which set viruses apart are their possession of only one type of nucleic acid, either DNA or RNA, but never both as in all other organisms; their lack of ribosomes and of energy-producing enzymes; and their inability to grow or divide. Viruses multiply solely from their genetic material of DNA or RNA when this is introduced into a susceptible cell and provides a code for the production of new virus genetic material and structural components. In essence viruses are infectious pieces of genetic material that are parasitic on living cells. The known range of viruses includes agents that multiply in the cells of vertebrates, plants, arthropods and bacteria. Certain newly-recognised viruses have defective genetic material and can multiply only in cells in which "helper" viruses are also multiplying. Such agents are almost parasites of other viruses.

Much progress has been made towards the grouping (classifying) of related viruses by a consideration of the nature of their genetic material and of certain stable features of the infectious particle or virion. Agreement on the nomenclature and taxonomic status of these groups has been more difficult to obtain, and we can expect further changes in the names of even the better studied veterinary viruses. The recently compiled report of the International Committee on Nomenclature of Viruses (Wildy 1971) lists 43 virus groups (some are referred to as genera and a few are grouped into families), and several contain viruses with hosts in different phyla. Nineteen genera include viruses that infect domestic animals, laboratory animals or man, and Table 1 is based on information from this publication. This material must not be regarded as final, and Wildy (1971) described the proposed system as "the first step".

Pathogenesis and Host Resistance

The interaction of the virus and host, a process that sometimes results in disease, is of practical importance to the veterinarian. It must be recognised that infection does not always result in disease, and that disease may be a relatively rare outcome of this interaction. Simon (1960) described the situation very succinctly: ". . . an infectious agent is found to be a *necessary,* but not necessarily a *sufficient,* determinant for the development of infectious disease". We should not lose sight of the modifying influences of host genotype, environment and interacting infectious agents.

Some insight into the pathogenesis of viral infections has been gained from the use of germ-free animals. Surprisingly, many veterinary viruses that produce severe disease in conventional animals cause only mild disease in the germ-free host. This is so for both distemper (Gibson *et al* 1965) and feline panleucopenia (Rohovsky and Griesemer 1967). In fact, the herpesvirus of feline rhinotracheitis is an unusual virus in producing a disease in germ-free animals comparable in severity with that seen naturally (Hoover *et al* 1970).

For some viruses the early events of infection are modified by the presence of neutralising antibody, either in plasma or at sites of entry. For other viruses, resistance is a cell-mediated function, and resistance can be transferred with cells but not with serum. It was believed that the factors that lead to recovery from viral diseases were nonspecific—interferon production, pyrexia, hypoxia and acidosis and interactions of these (Baron 1963). This generalisation does not seem to hold for all viruses, and it is now known that the outcome of infection with canine distemper virus is determined by the antibody response that is achieved by the ninth day after infection. Adequate amounts of antibody confine the virus harmlessly to the lymphatic organs, and prevent the spread of virus to epithelial tissues, where the characteristic lesions are produced (Appel 1969). However, viruses are a very diverse

TABLE 1

A Classification of Some Animal Viruses Compiled from Wildy (1971)

Genera Not Assigned to Families

Genus Poxvirus In six subgenera (A to F) are included more than 30 poxviruses including those of cowpox, contagious ovine ecthyma (orf), lumpy skin disease, fowlpox, myxoma and swinepox.

Genus Iridovirus The virus of African swine fever is included in this group of mainly insect viruses.

Genus Herpesvirus This group of over 35 viruses will probably require subdivision in the future. The group includes infectious bovine rhinotracheitis and Marek's disease viruses.

Genus Adenovirus Most species of domestic animals are hosts to adenoviruses.

Genus Reovirus Includes reovirus of mammals and poultry. The extensive list of possible members including bluetongue virus and African horsesickness virus will probably necessitate further subdivision.

Genus Leukovirus These viruses cause leucosis in birds, rodents and cats.

Genus Orthomyxovirus The true influenza viruses are included in this group.

Genus Paramyxovirus Includes Newcastle disease virus and the parainfluenza viruses, with distemper and rinderpest viruses possible members.

Genus Rhabdovirus The members and possible members include vesicular stomatitis virus, rabies virus and bovine ephemeral fever virus.

Genus Alphavirus This contains the arboviruses of Group A. These viruses and the following genus will probably be included in the same family.

Genus . . . . . No generic name was suggested for the arboviruses of Group B, which include the viruses of yellow fever and Murray Valley encephalitis.

Genus Coronavirus Avian infectious bronchitis virus is the type species.

Genus Arenavirus Includes murine lymphocytic choriomeningitis virus.

Genus Parvovirus Includes feline panleucopenia virus.

Family Papovaviridae

Genus Papillomavirus Includes the viruses producing warts on animals.

Genus Polyomavirus Includes rodent polyoma virus.

Family Picornaviridae

Genus Calicivirus Includes vesicular exanthema virus and feline picornaviruses.

Genus Rhinovirus Foot-and-mouth disease virus is the best known veterinary member.

Genus Enterovirus Includes viruses from man, cattle, pigs and birds.

group of agents, and the relative importance of the various defence mechanisms will probably vary with the nature of the infecting virus and of the host.

Control and Therapy

Control of viral diseases is still based on the use of vaccines. The eventual aim is to prepare vaccines containing only the immunogenic fractions of the virus particle, but for the present veterinary vaccines contain whole virions. Unless the virus is highly immunogenic and can be prepared in high titres, living attenuated vaccines seem to be more useful than inactivated vaccines. The production of veterinary vaccines will probably progress along lines now advocated for human vaccines, with production in diploid cell cultures that have been thoroughly tested for adventitious agents.

Therapeutic substances of commercial value remain elusive. Much work is at present being undertaken on rifampicin and its derivatives, which give promise of acting specifically on virus polymerases. The use of interferon, after a period of fading hopes, is being re-examined for chemotherapy of both viral diseases and tumours (Graff *et al* 1970). Large-scale production will be difficult. Experiments continue with both natural and synthetic interferon inducers. There are many problems, including toxicity, biological activities other than interferon production, enzymatic degradation of some inducers, antibody response to others, and the lack of immune response in animals in which a viral infection has been suppressed. Veterinary use of the agents will probably be long delayed.

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