Caliciviruses
Brief Review

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Introduction

Calicivirus is listed as a possible genus in the family Picornaviridae (27). Caliciviruses do resemble the 2 recognised genera Enterovirus and Rhinovirus of the family Picornaviridae in many of their properties. Thus they are relatively small, lipid solvent resistant viruses that contain a single-stranded, non-segmented RNA and replicate in the cytoplasm. However, some basic differences between caliciviruses and picornaviruses are recognised. Caliciviruses are larger (diameter 35–40 nm, compared to 22–27 nm for picornaviruses), their morphology in negatively stained electron micrographs is distinctive and definable, and their capsid is composed of a single major polypeptide, compared with 4 polypeptides in the capsid of picornaviruses. Caliciviral RNA unlike that of picornavirus RNA is not translated as a single, multicistronic messenger RNA. These differences may result in the delineation of a separate family—Caliciviridae.

Caliciviruses thus far are remarkably restricted in their natural host range having been isolated from porcine (domestic pig), pinniped (San Miguel sea lion, Alaskan fur seal) and feline (domestic cat, cheetah) species. This restricted occurrence is highlighted further by the fact that the porcine and pinniped viruses are probably identical. There is now good evidence that the porcine caliciviruses were originally acquired from pinnipeds in what has emerged as an interesting and instructive epizootiological relationship.

The purpose of this article is to review the general properties of caliciviruses and to summarise information about the diseases with which they are associated.

Nomenclature and Abbreviations

Vesicular exanthema of swine (VES); Vesicular exanthema of swine virus (VESV); San Miguel sea lion virus (SMSV); Feline calicivirus (FCV); Foot- and-mouth disease (FMD); Vesicular stomatitis (VS); Swine vesicular disease (SVD); Specific-pathogen-free (SPF).
History

Calicivirus history began in 1932 with the recognition of a disease subsequently named vesicular exanthema of swine (VES) in southern California (82). VES attracted considerable attention because clinically it was indistinguishable from foot and mouth disease (FMD) which in the United States and in many other countries was and still is a disease controlled by slaughter. At the time VES had also to be distinguished from vesicular stomatitis (VS) and would now also need to be distinguished from swine vesicular disease (SVD).

The history of feline caliciviruses (FCV) could be said to date from 1957. In that year Fastier (25) in New Zealand and Bolin (12) in the United States described attempts to isolate panleukopaenia virus (an autonomously replicating parvovirus requiring actively dividing cells for growth). Both recovered rapidly cytopathic viruses when spleen suspensions from cats dying of panleukopenia were inoculated onto confluent monolayers of feline cell cultures. These viruses were FCV. Subsequently FCV were frequently isolated and shown to be a major cause of feline respiratory disease in many parts of the world.

The first pinniped calicivirus was isolated in 1972 from California sea lions (Zalophus californianus californianus) during an investigation of abortion among these sea lions on San Miguel Island, one of the Channel Islands off the Californian coast. The virus was called San Miguel sea lion virus (SMSV). Subsequently a similar virus was isolated from northern fur seals (Callorhinus ursinus) on St. Paul Island, one of the Pribilof Islands, Alaska. The role of SMSV as a cause of disease in pinniped species has not been fully defined.

The Viruses

We are concerned with viruses isolated from 3 mammalian species—porcine (VESV), pinniped (SMSV) and feline (FCV). No major differences have emerged in the fundamental properties of the viruses isolated from the 3 species, hence the descriptions of the properties which follow are believed generally applicable to all. Data are unevenly available, hence an overview is provided.

Morphology

The general morphology of caliciviruses in negatively stained electron micrographs (Fig. 1) has been described by Zwillenberg and Bürki (93), Almeida et al. (3), Wawrzewicz et al. (87) and Peterson and Studdert (53). Mean virion diameter in such preparations is about 37 nm (range 32 to 40 nm). The appearance of the virion is distinctive. The virus is roughly spherical or polyhedral and the surface is patterned by dark, spherical spots about 10 nm in diameter. The dark spots are deposits of negative stain filling cup-shaped (hence the name calici from Latin calyx for cup or chalice) depressions on the surface of the virion.

There are 32 such dark spots, 12 located at the vertices and 1 on each of 20 facets on the icosahedron. The dark areas are observed in several characteristic patterns depending upon the axis through which a particular virion is viewed (Fig. 2). The most common arrangement, corresponding to the 2-fold axis of symmetry, is 4 dark areas in a rhomboid pattern, the intervening light areas appearing as a prominent cross. Other arrangements include a central dark area surrounded by 6 similar areas and a central dark area surrounded by 5 similar