



New viruses associated with canine gastroenteritis

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ABSTRACT

A number of novel viruses have been associated with canine gastroenteritis in recent years, from viral families as diverse as *Caliciviridae* and *Picornaviridae* to *Parvoviridae* and *Circoviridae*. The ability of many of these viruses to cause disease is uncertain, but epidemiological studies are continually adding to our knowledge of these potential pathogens. This review presents a summary of the latest research and current understanding of novel viruses associated with canine gastroenteritis.

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Introduction

Viral gastroenteritis is a common clinical problem in dogs, and viruses are detected in 40–60% diarrhoeic faecal samples (Decaro et al., 2009; Baumann et al., 2014). For several decades, the most widely recognised cause of viral gastroenteritis in dogs has been canine parvovirus (CPV), but there has been a recent surge in identification of new viruses in association with canine diarrhoea. Altogether, at least seven novel viruses have been characterised from diarrhoeic faecal samples in the past few years. These are listed in Fig. 1 according to their viral family, alongside the four canine gastroenteric viruses identified prior to 1980: CPV, canine enteric coronavirus (CECoV), canine rotavirus and canine distemper virus.

Historically, viral detection has been based on electron microscopy (EM), with capsid morphology enabling viral classification (Fig. 2). This was the means by which CPV and CECoV were first characterised in the 1970s (Binn et al., 1974; Thomson and Gagnon, 1978). The use of molecular methods, such as PCR, later enabled a more focussed approach to virus identification, with some canine viruses being discovered by screening for related viruses of other species. This is exemplified by the identification of canine norovirus by screening samples using a broadly reactive primer pair targeting caliciviruses (Martella et al., 2008).

The most significant development in advancing viral discovery has been the advent of next generation sequencing (NGS). Unbiased analysis of nucleic acid from diarrhoeic samples of dogs has enabled identification and characterisation of several

previously unknown viruses. These include canine sapovirus, canine kobuvirus, canine circovirus and canine bocavirus (Li et al., 2011; Carmona-Vicente et al., 2013; Bodewes et al., 2014).

However, mere identification of a novel virus in a faecal sample from a dog with gastroenteritis is insufficient to confirm that the virus is the cause of the clinical signs. Co-infections with other viruses are common and elucidating which virus, if any, is inducing disease can be problematic. The suggestion that a newly identified virus may cause gastrointestinal pathology often comes from understanding related viruses in other species; for example, if a similar virus is known to cause gastroenteritis in humans, it may be suspected that related canine viruses will induce the same pathology in dogs. Another reason to suspect a novel virus is a cause of canine gastroenteritis typically arises from epidemiological studies. Identification of the virus in diarrhoeic samples at a significantly higher frequency than in faecal samples from healthy dogs suggests that the novel virus could be the cause of clinical disease. Nonetheless, definitive evidence that a virus can cause gastrointestinal pathology requires experimental infections. Experimental infections have confirmed that CPV, CECoV, canine rotavirus and canine distemper virus induce gastroenteritis in their hosts (Dunkin and Laidlaw, 1926; Keenan et al., 1976; Johnson et al., 1983; Meunier et al., 1985; Pratelli et al., 2004), but similar experiments are yet to be performed for the viruses discovered over the past decade.

The aim of this is to provide a summary of the latest research on viruses that have most recently been identified in association with gastroenteritis in dogs. Each of the novel viruses suggested to be a pathogen of the canine gastrointestinal tract will be discussed, with specific consideration given to the present understanding of the epidemiology and clinical significance of each virus.

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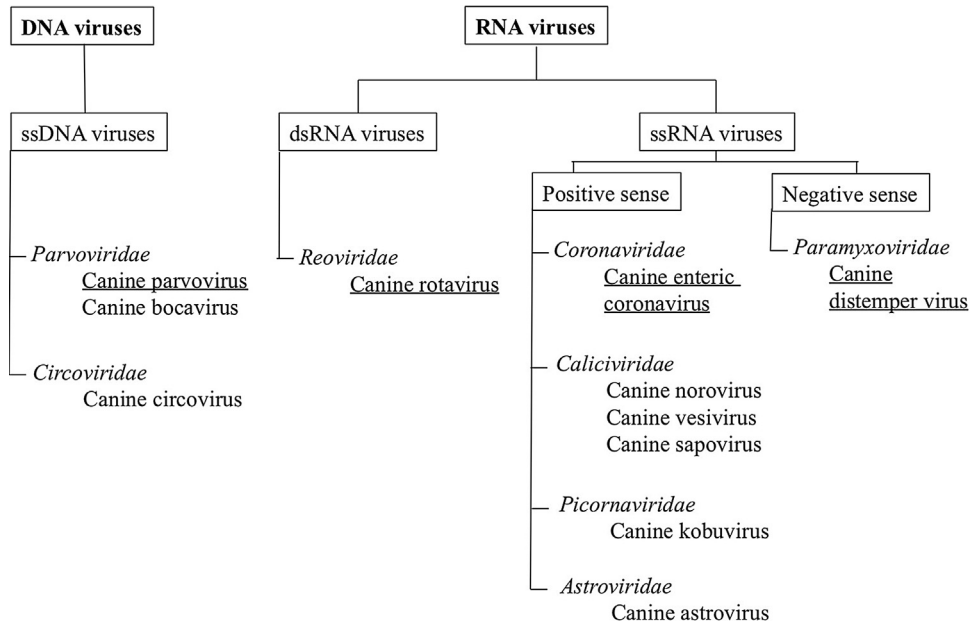


Fig. 1. Viruses associated with gastroenteritis in dogs. Viral families (listed in italics) are grouped according to their genome type, with viral species (or virus name most widely used in the literature) listed directly beneath. Viral species underlined have been proven to cause gastroenteritis in dogs by experimental studies.

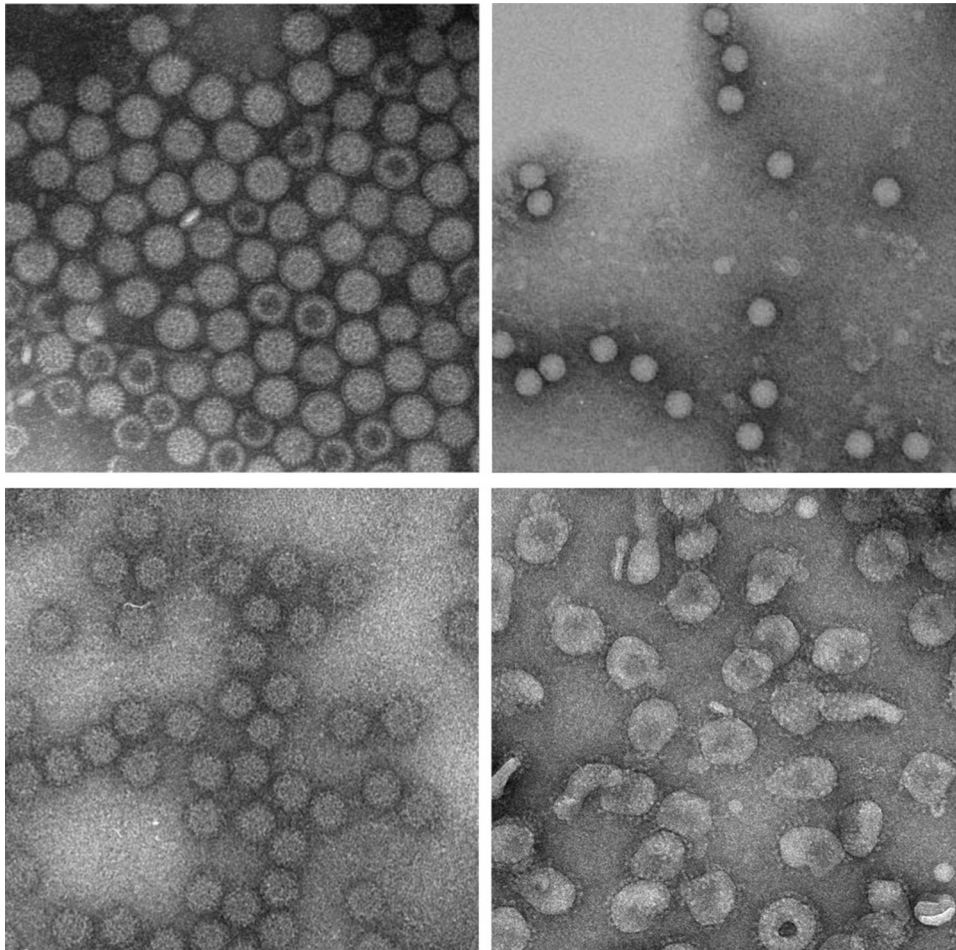


Fig. 2. Electron micrographs of a selection of viruses associated with gastroenteritis in dogs. Top left; rotavirus, top right; picornavirus, bottom left; calicivirus, bottom right; coronavirus. Images courtesy of D. Bhella, University of Glasgow.

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