

# Pathology in Practice

In cooperation with



Figure 1—Photograph of 3 portions of the small intestine of an 8-day-old Holstein calf that had watery diarrhea of 1 day's duration and died. Notice that the mucosa of the small intestine is diffusely reddened and covered by a viscous yellow material.

## History

An 8-day-old 40-kg (88-lb) female black and white Holstein calf died and was submitted for necropsy within a few hours after death. Prior to death, the calf was weak, had signs of depression, and had a 1-day history of watery diarrhea. The clinical veterinarian reported that up to 20% of calves in the herd had signs of gastrointestinal tract disease and that the mortality rate among affected calves was 4%. The herd included 1,900 milking cows, with year-round calving, and was negative for bovine viral diarrhea virus infection.

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## Clinical and Gross Findings

Grossly, the calf was in fair body condition with adequate adipose tissue deposition. The mucous membranes were markedly pale, and the eyes were slightly sunken. A small amount of dark tan fecal material was matted to the hair in the perineal region and tailhead. Contents of the small intestine were yellow and slightly frothy. The mucosa of extensive segments of the small intestine, especially the duodenum and jejunum, was diffusely reddened and covered by viscous yellow material (Figure 1). The mesenteric lymph nodes were enlarged and wet on cut surface. There was a small amount of white foam within the trachea and primary bronchi. Admixed with ruminal, omasal, and abomasal content, there was a moderate quantity of sand.

Formulate differential diagnoses from the history, clinical findings, and Figure 1—then turn the page →

## Histopathologic Findings

The most remarkable histopathologic findings were in the small intestine, where there were locally extensive areas of moderate villous blunting and fusion. In locally extensive areas, embedded within the apical

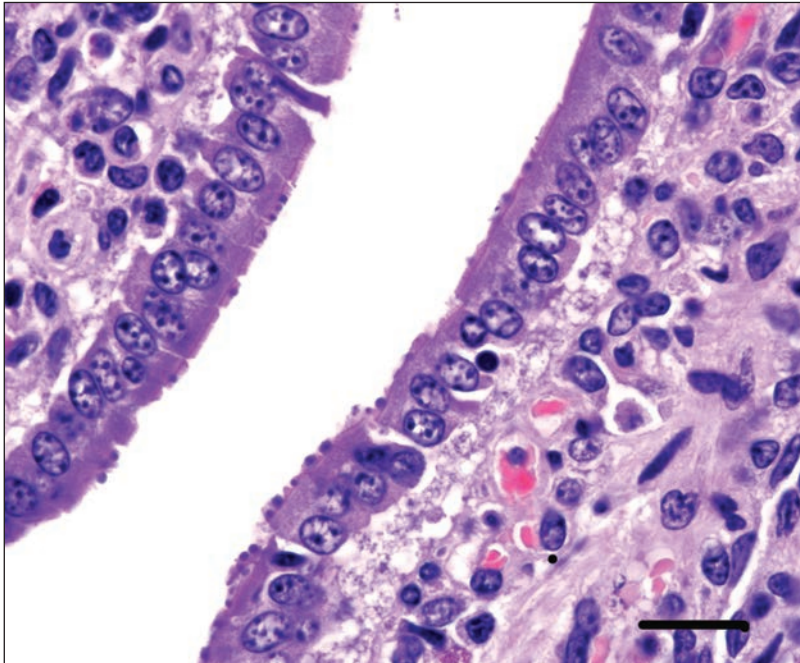


Figure 2—Photomicrograph of a section of the small intestine of the calf in Figure 1. Incorporated into the microvilli of the enterocytes, there are large numbers of 2- to 6- $\mu$ m-diameter, round, basophilic structures (*Cryptosporidium* sp). The lamina propria is infiltrated by numerous lymphocytes, plasma cells, and macrophages and fewer eosinophils and neutrophils. H&E stain; bar = 0.1 mm.

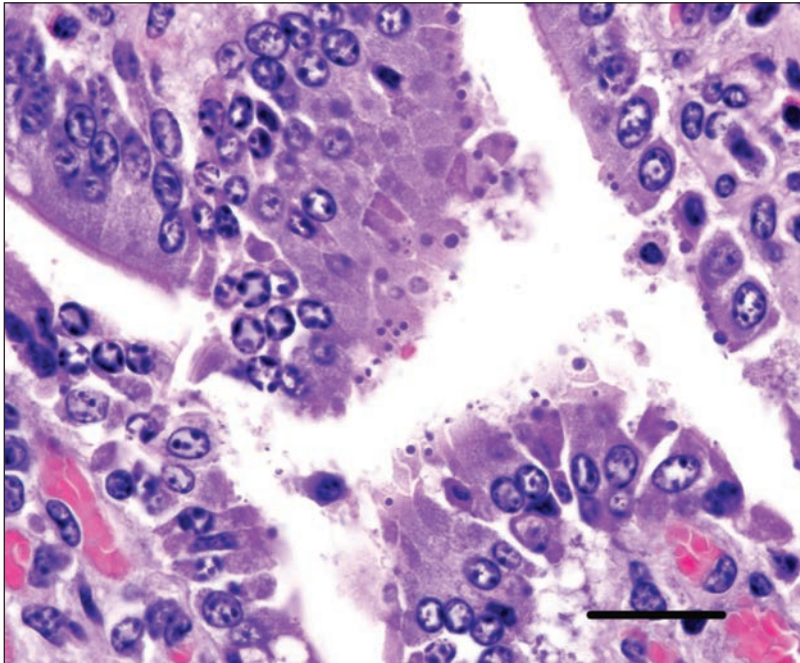


Figure 3—Photomicrograph of another section of the small intestine of the calf in Figure 1. Notice the loss of adhesion between enterocytes. The brush border is ruptured with numerous intracellular *Cryptosporidium* organisms. Multifocally, there is disruption of the epithelium with lamina propria exposure. H&E stain; bar = 0.1 mm.

portion of the villus epithelial cells, were myriad 2- to 6- $\mu$ m-diameter, round, basophilic structures (morphologically compatible with *Cryptosporidium* spp; Figure 2). Occasionally, irregular mucosal thickness and enterocyte exfoliation were present (Figure 3). The lamina propria of these affected segments of intestine was infiltrated by large numbers of lymphocytes, plasma cells, and macrophages and few eosinophils and neutrophils. Scattered crypts were filled with moderate numbers of neutrophils and cellular debris. Also, there were multifocal areas of hemorrhage scattered throughout the mucosa of the affected areas. The centers of the Peyer's patch follicles were hypocellular, characterized by small numbers of macrophages with fewer lymphocytes and neutrophils and moderate amounts of eosinophilic material. The normal architecture of the mesenteric lymph nodes was distorted because of diffuse infiltrates of lymphocytes, plasma cells, and macrophages, admixed with multifocal infiltrates of degenerated and non-degenerated neutrophils, all embedded within an edematous matrix. In the rumen and reticulum, there were multifocal aggregates of neutrophils within the epithelium of the papillae.

## Additional Test Findings

A section of small intestine was submitted for fluorescent antibody testing to detect infection with *Cryptosporidium* spp or bovine rotavirus. Polymerase chain reaction assays to identify bovine viral diarrhea virus and *Salmonella* spp were also applied to intestinal tissue sections.

## Morphologic Diagnosis and Case Summary

Morphologic diagnosis: severe, locally extensive to diffuse, lymphoplasmacytic and necrotizing enteritis, with villus atrophy and myriad protozoal organisms (*Cryptosporidium* spp); mild, multifocal, suppurative rumenitis and reticulitis, secondary to sand ingestion.

Case summary: diarrhea associated with *Cryptosporidium* infection in a 1-week-old calf.

## Comments

Clinical, gross, and microscopic findings in the case described in this report were all consistent with bovine cryptosporidiosis. Results of fluorescent antibody testing of intestinal sections for cryptosporidia were positive, confirming the diagnosis. *Cryptosporidium parvum* is the species that most frequently affects young calves.<sup>1</sup> This organism is

the most prevalent species infecting preweaned calves; *Cryptosporidium ryanae* and *Cryptosporidium bovis* infections are most prevalent in postweaned calves, and *Cryptosporidium andersoni* infection is most prevalent in adult cows.<sup>1</sup> Including these species, there are 16 species in this genus of protozoans, and all groups of vertebrates, including humans, are susceptible to *Cryptosporidium* infection.<sup>2</sup> In addition to cryptosporidiosis, differential diagnoses for diarrhea in very young calves include infection with enterotoxigenic *Escherichia coli*, bovine coronavirus, bovine rotavirus, bovine viral diarrhea virus, and *Salmonella* spp.<sup>3,4</sup> Also, ingestion of nutritionally inadequate milk replacers containing heat-denatured protein must be considered as a diagnosis of exclusion when neither lesions nor agents are found in affected calves.<sup>3</sup> In the case described in the present report, various ancillary tests were done immediately after necropsy. Tests included PCR assays for bovine viral diarrhea virus and *Salmonella* spp and fluorescent antibody testing for rotavirus and *Cryptosporidium* spp. Results of all tests, except the fluorescent antibody testing for *Cryptosporidium* spp, were negative.

*Cryptosporidium parvum* is a zoonotic and ubiquitous protozoan and a leading cause of calf morbidity.<sup>2-6</sup> Oocysts are shed within 4 days following infection and continue to be shed for a period of 1 to 2 weeks, resulting in heavy environmental contamination, including the potential for entering water supplies through watersheds<sup>2-5,7</sup> or by means of mechanical vectors and fomites.<sup>6</sup> If kept moist, the oocysts can survive in the environment for months.<sup>7</sup> Transmission occurs via the fecal-oral route; thus, food and waterborne infections are common.<sup>2,5-7</sup> Infected calves can be subclinically affected, can develop clinical signs ranging from mild to profuse diarrhea and dehydration, and, in some cases, can die.<sup>4,5</sup> Because of the large numbers of oocysts shed by infected animals, herd prevalence is generally very high. Infection control is challenging, and maintaining a healthy immunocompetent herd along with promoting environmental desiccation to decrease the infective burden is considered the only truly effective means of prevention.<sup>5,7</sup>

In the host, all stages of the *Cryptosporidium* spp life cycle occur extracytoplasmically in a protruding vacuole surrounded by the enterocyte cell membrane within the brush border, especially in the distal half of the small intestine.<sup>3-5</sup> The affected intestine may have diffusely reddened mucosa, and contents are fluid.<sup>3,5</sup> Microscopically, hypertrophy of crypts of Lieberkühn, blunting and some fusion of the villi,<sup>3-5</sup> and large numbers of 2- to 6- $\mu$ m-diameter,<sup>3</sup> basophilic structures attached to the microvillus border of the remaining enterocytes are evident.<sup>3,5</sup> Mixed inflammatory cells are seen in the lamina propria.<sup>3-5</sup>

Cryptosporidiosis in humans is primarily caused by *Cryptosporidium hominis* and *C parvum*.<sup>2-4,6</sup> The former is the cause of most outbreaks in humans and has an exclusive transmission cycle in this species, whereas the latter is zoonotic.<sup>2,3,5,8</sup> In humans, as in other animals, cryptosporidiosis is mainly characterized by diarrhea, which is self-limited in immunocompetent individuals but can be life-threatening in those who are immunocompromised.<sup>5,8</sup>

The farm on which the calf of this report resided had some concurrent problems with salmonellosis in calves. After these 2 enteric diseases were diagnosed (cryptosporidiosis and salmonellosis), the farm changed its management, and instead of keeping calves in individual hutches until 7 days of age, they extended the period of individual housing until 14 days of age. This helped to decrease the frequency of enteric problems.

Given that *C parvum* is a common enteric pathogen of calves that is easily spread from animal to animal and can result in heavy environmental contamination and subsequent human infection,<sup>4,7</sup> it is important to institute effective prophylaxis and prevention measures<sup>4,6</sup> on cattle farms. When cryptosporidiosis is diagnosed in calves, personal hygiene measures to decrease potential for spread of the disease to other animals and humans should be taken.<sup>4</sup>

## References

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