

## Life cycle and biology of *Neospora caninum*

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### Abstract

The protozoan parasite *Neospora caninum* causes serious clinical illness in dogs and cattle. Clinical neosporosis has also been occasionally reported in horses, goats, sheep, deer, rhinoceros, llamas, and alpacas. However, *N. caninum* has been isolated only from cattle, dogs, sheep, water buffaloes, and the white-tailed deer. Antibodies to *N. caninum* have also been reported in raccoons, camels, pigs, horses, cats, foxes, coyotes, and other wild canids. Primates have been infected experimentally, but evidence of *N. caninum* infection in humans is lacking.

Dogs (*Canis familiaris*) and coyotes (*Canis latrans*) are the only definitive hosts for *N. caninum*. There are 3 infectious stages of the parasite: tachyzoites, bradyzoites, and sporozoites. Tachyzoites and bradyzoites are found in tissues whereas sporozoites are present in oocysts that are excreted in canine feces. Tachyzoites are lunate-shaped and measure approximately 2 x 6  $\mu$ m. They occur in many cell types including neural cells, vascular endothelial cells, myocytes, hepatocytes, renal cells, alveolar macrophages, and placental trophoblasts.

Bradyzoites are approximately 6.5 x 1.5  $\mu$ m in size. They have a terminally located nucleus and several amylopectin granules that stain red with periodic acid Schiff (PAS) reaction, whereas tachyzoites lack amylopectin granules and the nucleus in tachyzoites is located centrally. Bradyzoites are found inside tissue cysts. Tissue cysts in dogs are up to 107  $\mu$ m in diameter and the tissue cyst wall is up to 4  $\mu$ m thick. However, little is known about the formation and persistence of tissue cysts in cattle. In cattle tissue cysts are rarely more than 50  $\mu$ m in diameter and the tissue cyst wall is usually less than 2.5  $\mu$ m thick. All information on tissue cysts in cat-

tle is based on examination of tissues of fetuses and congenitally-infected calves. *Neospora caninum* has never been seen in sections of tissues of experimentally or naturally-infected adult cattle. Information on the persistence and locale of *N. caninum* tissue cysts is important in transmission of the parasite. Tissue cysts occur in the brain and spinal cord of fetuses and calves. A few thin-walled tissue cysts have been reported in skeletal muscles of two 2-day old naturally infected calves. In experimentally-infected cattle, a single tissue cyst was found in the brain of a fetus 32 days after inoculation of the dam with *N. caninum*; this tissue cyst was 11 x 9  $\mu$ m in size. The distribution of tissue cysts in cattle has not been critically evaluated.

The persistence of *N. caninum* and the stage of the parasite present in placentas of cattle is of epidemiologic importance because the enormous amount of fetal membranes (in kilograms) from naturally-infected cattle are available for carnivores to ingest and acquire *N. caninum* infection. One study reported isolation of *N. caninum* from 20 g samples of placentas from 3 naturally-infected cows that had delivered 9 healthy but infected calves in 3 consecutive pregnancies. Dogs fed naturally-infected placentas shed *N. caninum* oocysts. It will be of interest to know if bradyzoites occur in bovine placentas using immunohistochemical staining with bradyzoite-specific antibodies.

*Neospora caninum* oocysts are excreted unsporulated in canine feces. They are approximately 10 x 12  $\mu$ m in size. Sporulation occurs outside the body. Sporulated oocysts contain 2 sporocysts and each sporocyst has 4 sporozoites. The sporozoites are 6.5 x 2  $\mu$ m in size. Experimentally, dogs have shed oocysts after ingesting naturally-infected tissues from cattle, water buffalo and white-tailed

