

Neospora caninum is a coccidian parasite that was identified as a species in 1988. Prior to this, it was misclassified as *Toxoplasma gondii* due to structural similarities.^[1] The genome sequence of *Neospora caninum* has been determined by the Wellcome Trust Sanger Institute and the University of Liverpool. *Neospora caninum* is an important cause of spontaneous abortion in infected livestock.

Life cycle and transmission

Neospora caninum has a heteroxenous life cycle, with the sexually reproductive stage occurring in the intestine of a definitive host. Until recently, the only known definitive host was the domestic dog.^[1] New research has determined that other canids such as coyotes (*Canis latrans*), gray wolves (*Canis lupus*), and Australian dingos (*Canis lupus dingo*) are also definitive hosts.^{[4][5][6]}

Oocysts passed in the feces of the definitive host, such as canines or canids, are ingested by an intermediate host, such as cattle. After ingestion of an oocyst, motile and rapidly dividing tachyzoites are released. These tachyzoites disseminate throughout the host, and in response to the host immune response, differentiate into bradyzoites, which form cysts in muscle and tissue. Formation of these cysts results in chronic infection of the intermediate host. Ingestion of infected intermediate host tissue by the definitive host completes the life cycle. A second route of transmission is the congenital transmission from mother to offspring.^[7] Transplacental transmission (passage from mother to offspring during pregnancy) has also been shown to occur in dogs, cats, sheep and cattle. If the intermediate host acquires the disease during pregnancy, it activates these cysts, and active infection often causes spontaneous abortion.^[7] In addition, if the aborted fetus and membranes are then eaten by the definitive host, they cause further infection and the cycle is complete. Other carnivores, for example the red fox (*Vulpes vulpes*), may also be intermediate hosts, but they are not known to be definitive hosts.^[8] *Neospora caninum* does not appear to be infectious to humans. In dogs, *Neospora caninum* can cause neurological signs, especially in congenitally infected puppies, where it can form cysts in the central nervous system.^[9]

The discovery that coyotes are definitive hosts may increase the risk of transmission of *N. caninum* to domestic livestock as well as to wild ruminants such as white tailed deer (*Odocoileus virginianus*).^[10] Coyote range now includes most of North and Central America.^[5] Studies suggest that the parasite may be widespread among wildlife and that infection cycles cross over between wild and domestic animals.^[10]

Recent studies have broadened the list of known intermediate hosts to include birds.^[11] *N. caninum* has recently been found to infect domestic chickens and house sparrows (*Passer domesticus*) which may become infected after ingesting parasite oocysts from the soil.^{[11][12]} Sparrows, which are common in urban and rural areas, may serve as a food source for wild and domestic carnivores.^[12] *N. caninum* has also been detected in common buzzards (*Buteo buteo*) and magpies.^[11] The presence of birds in cattle pastures has been correlated to higher infection rates in cattle.^[13] Birds may be an important link in the transmission of *N. caninum* to other animals.^[11]

Clinical Disease

Neosporosis is an infectious disease for many different canids and cattle.^[1] Neuromuscular degeneration was first observed in canines in Norway, which led to hind limb paralysis.^[2] Abortion in dairy cattle was also observed as a major cause of disease by neosporosis.^[2] Although this disease is worldwide, it is of major concern in the United States, Netherlands, and New Zealand.^[2]

N. caninum infections have been reported from most parts of the world with studies in the United States, New Zealand, the Netherlands, Germany, and Portugal.^[14] 12-45% of aborted fetuses from dairy cattle are infected with the organism. Exposure is common in US dairy herds ranging from 16% to 36% of dairy cows testing positive on serum. ^[2] The majority of calves that acquire a *Neospora* infection during gestation are born clinically normal except that they have precolostral antibody titers to *Neospora caninum*. ^[3]

Treatment and control

In addition to being an important cause of cattle abortions, neosporosis is a significant disease in dogs throughout the world.^[15] If the disease is caught early, dogs may be successfully treated with clindamycin and other antiprotozoan drugs.^[15] However, the disease is often fatal to young puppies.^[15] Preventative vaccines have been tested on cattle.^{[16][17]} An inactivated vaccine was made commercially available but had mixed results.^[18] A live vaccine using attenuated *N. caninum* tachyzoites has been more successful but is expensive to produce.^[18] Other treatment options aim at prevention of the disease. Prevention requires an understanding of the transmission cycle, especially the connection between cattle and dogs (canids). Canids may pick up the parasite from eating infected material and spread the disease through contaminated feces.^[18] One control method is to test for the disease and remove infected cattle from the herd.^[18] Another method of control is preventing canids from entering the cattle holding area.^[18]

References

Dubey JP (Oct 1999). "Neosporosis—the first decade of research". *Int J Parasitol.* **29** (10): 1485–8. doi:10.1016/S0020-7519(99)00134-4. PMID 10608433.

1. Reid AJ, Vermont SJ, Cotton JA, Harris D, Hill-Cawthorne GA, Konen-Waisman S, Latham SM, Mourier T, Norton R, Quail MA, Sanders M, Shanmugam D, Sohal A, Wasmuth JD, Brunk B, Grigg ME, Howard JC, Parkinson J, Roos DS, Trees AJ, Berriman M, Pain A, Wastling JM (2012). "Comparative Genomics of the Apicomplexan Parasites *Toxoplasma gondii* and *Neospora caninum*: *Coccidia* Differing in Host Range and Transmission Strategy". *PLoS Pathogens* **8** (3): e1002567. doi:10.1371/journal.ppat.1002567. PMC 3310773. PMID 22457617.
2. McAllister MM, Dubey JP, Lindsay DS, Jolley WR, Wills RA, McGuire AM (Sep 1998). "Dogs are definitive hosts of *Neospora caninum*". *Int J Parasitol.* **28** (9): 1473–8. doi:10.1016/S0020-7519(98)00138-6. PMID 9770635.
3. Dubey, JP; MC Jenkins; C Rajendran; K Miska; LR Ferreira; J Martins; OCH Kwok; S Choudhary (September 2011). "Gray Wolf (*Canis lupus*) is a natural definitive host for *Neospora*

- caninum*". *Veterinary Parasitology* **181** (2-4): 382–387. doi:10.1016/j.vetpar.2011.05.018. PMID 21640485. Retrieved 20 February 2012.
4. Gondim, LFP; MM McAllister; WC Pitt; DE Zemlicka (February 2004). "Coyotes (*Canis latrans*) are definitive hosts of *Neospora caninum*.". *International Journal for Parasitology* **34** (2): 159–161. doi:10.1016/j.ijpara.2004.01.001. Retrieved 20 February 2012.
 5. King, JS; Slapeta J; Jenkins DJ; Al-Qassab SE; Ellis JT; Windsor PA (July 2010). "Australian dingoes are definitive hosts of *Neospora caninum*". *International Journal of Parasitology* **40** (8): 945–950. doi:10.1016/j.ijpara.2010.01.008. PMID 20149793.
 6. "Neosporosis". United States Department of Agriculture Agricultural Research Service. USDA. November 7, 2005. Retrieved 26 November 2013.
 7. Almería S, Ferrer D, Pabón M, Castellà J, Mañas S (Aug 2002). "Red foxes (*Vulpes vulpes*) are a natural intermediate host of *Neospora caninum*". *Vet Parasitol.* **107** (4): 287–94. doi:10.1016/S0304-4017(02)00162-0. PMID 12163240.
 8. Barber JS, Payne-Johnson CE, Trees AJ (Dec 1996). "Distribution of *Neospora caninum* within the central nervous system and other tissues of six dogs with clinical neosporosis". *J Small Anim Pract* **37** (12): 568–74. doi:10.1111/j.1748-5827.1996.tb02332.x. PMID 8981277.
 9. Gondim, LFP; McAllister MM; Mateus-Pinilla NE; Pitt WC; Mech LD; Nelson ME (December 2004). "Transmission of *Neospora caninum* between Wild and Domestic Animals". (PDF). *The Journal of Parasitology* **90** (6): 1361–1365. doi:10.1645/ge-341r. Retrieved April 4, 2012.
 10. Darwich, L; Cabezón O; Echeverría I; Pabón M; Marco I; Molina-López R; Alarcia-Alejos O; López-Gatius F; Lavín S; Almería S (February 2012). "Presence of *Toxoplasma gondii* and *Neospora caninum* DNA in the brain of wild birds.". *Veterinary Parasitology* **183** (3-4): 377–381. doi:10.1016/j.vetpar.2011.07.024.
 11. Gondim, Leane S. Q.; Kiyoko Abe-Sandes, Rosângela S. Uzêda, Mariana S.A. Silva, Sara L. Santos, Rinaldo A. Mota, Sineide M.O., Vilela, Luis F.P. Gondim (February 2010). "*Toxoplasma gondii* and *Neospora caninum* in sparrows (*Passer domesticus*) in the Northeast of Brazil". *Veterinary Parasitology* **168** (1-2): 121–124. doi:10.1016/j.vetpar.2009.09.055. Retrieved March 3, 2012. Cite uses deprecated parameter |coauthors= (help)
 12. Mineo, T.W.P.; A.O.T. Carrasco; T. F. Raso; K. Werther; A.A. Pinto; R.Z. Machado (December 2011). "Survey for natural *Neospora caninum* infection in wild and captive birds". *Veterinary Parasitology* **182** (2-4): 352–355. doi:10.1016/j.vetpar.2011.05.022.
 13. Maia, C.; Cortes, H.; Brancal, H.; Lopes, A. P.; Pimenta, P.; Campino, L.; Cardoso, L. (2014). "Prevalence and correlates of antibodies to *Neospora caninum* in dogs in Portugal". *Parasite* **21**: 29. doi:10.1051/parasite/2014031. PMID 24972327.
 14. Dubey, J.P.; Dorough, K.R.; Jenkins, M.C.; Liddell, S.; Speer, C.A.; Kwok, O.C.H.; Shen, S.K. (August 1998). "Canine neosporosis: clinical signs, diagnosis, treatment and isolation of *Neospora caninum* in mice and cell culture". *International Journal for Parasitology* **28** (8): 1293–1304. doi:10.1016/s0020-7519(98)00099-x.
 15. Andrianarivo, AG; Rowe, JD; Barr, BC; Anderson, ML; Packham, AE; Sverlow, KW; Choromanski, L; Loui, C; Grace, A; Conrad, PA (August 2000). "A POLYGEN-adjuvanted killed *Neospora caninum* tachyzoite preparation failed to prevent foetal infection in pregnant cattle following i.v./i.m. experimental tachyzoite challenge". *International Journal for Parasitology* **30** (9): 985–990. doi:10.1016/S0020-7519(00)00088-6.
 16. Romero, JJ; Pérez, E; Frankena, K. (September 2004). "Effect of a killed whole *Neospora caninum* tachyzoite vaccine on the crude abortion rate of Costa Rican dairy cows under field conditions". *Veterinary Parasitology* **123** (3-4): 149–159. doi:10.1016/j.vetpar.2004.06.016.
 17. Reichel, MP; Ellis, JT (September 2009). "*Neospora caninum* – How close are we to development of an efficacious vaccine that prevents abortion in cattle?". *International Journal for Parasitology* **39** (11): 1173–1187. doi:10.1016/j.ijpara.2009.05.007. Retrieved April 13, 2012.

