Echinococcus multilocularis: an emerging threat to canine and human health in Canada?

By Andrew S. Peregrine, BVMS, PhD, DVM, DEVPC, DACVM (Parasitology), and Jonathan Kotwa, BSc

Echinococcus multilocularis is a small (2-4 mm), zoonotic tapeworm that occurs in the small intestine of both wild and domestic canids, and less commonly in cats. When mature, eggs are shed in the feces that are morphologically identical to *Taenia*-type eggs. If ingested by wild rodents (the typical intermediate host), the larval stage of the parasite, an alveolar hydatid cyst, develops in the liver. Thereafter, the alveolar hydatid cyst undergoes exogenous budding, behaving like a tumour; the resultant disease is referred to as *alveolar echinococcosis*. Eventually, the parasite kills the intermediate host. If infected rodents are ingested by canids or cats, the parasite matures in the small intestine and the life cycle is completed (see Figure 1).

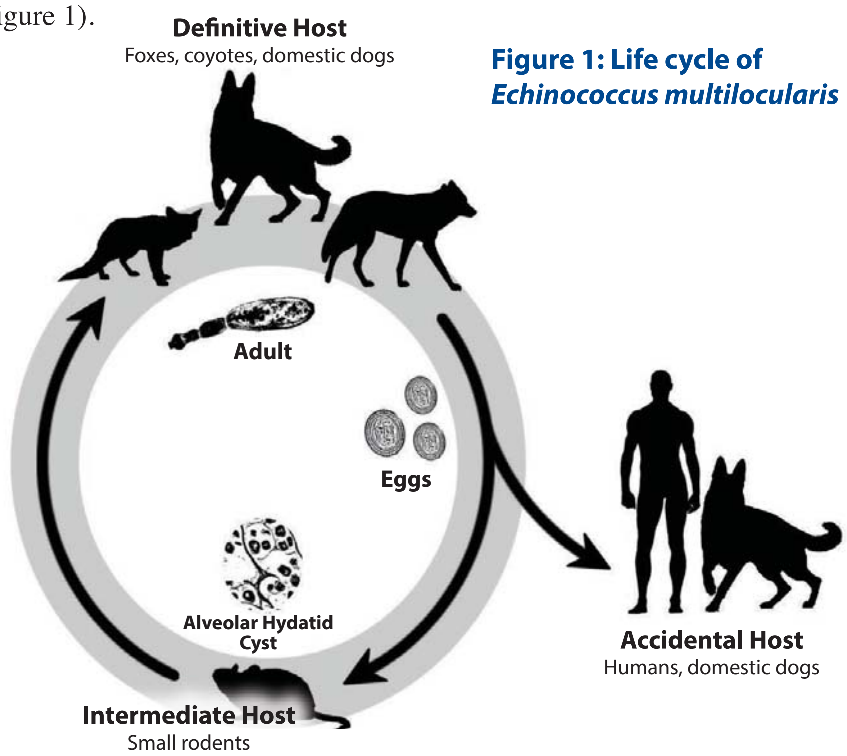

Figure 1: Life cycle of *Echinococcus multilocularis*

Echinococcus multilocularis is also a significant public health concern as ingestion of parasite eggs can result in the development of alveolar hydatid cysts in people, typically in the liver. Infections have a clinical incubation period of 5-15 years. In Switzerland and Germany, where *E. multilocularis* is currently an emerging public health concern, surgical resection of liver lesions and treatment with albendazole is the preferred method of management. For patients with non-resectable alveolar hydatid cysts, treatment with albendazole is required for an average duration of 9.4 years.

In North America, *E. multilocularis* was until very recently thought to be endemic in two distinct regions. The first, known as the Northern Tundra Zone, begins along the west coast of Alaska and extends northward and eastward to occupy most of the Canadian Arctic. The second, the North Central Region, consists of the southern portions of Alberta, Saskatchewan and Manitoba, along with 13 neighbouring US states. Within these regions, foxes and coyotes are considered the principal definitive hosts; voles and mice are the primary intermediate hosts.

In both Canada and the US, there are few documented cases of *E. multilocularis* infections in the intestine of domestic dogs or cats. Most notably, in 1951, 12% of dogs belonging to Alaskan Inuit on St. Lawrence Island were identified infected with *E. multilocularis*. High numbers of rodents and the high prevalence of infection in dogs are believed to be the reason that St. Lawrence Island had one of the highest rates of human alveolar echinococcosis in the world. However, quite surprisingly, despite the broad geographic distribution in the US, cases of dogs with intestinal *E. multilocularis* infections have not been described elsewhere in the US. Similarly, in Canada, *E. multilocularis* has only been described in the feces of 1/218 dogs in Calgary, AB (in 2014). Likewise, very few cases have been reported in cats; two in North Dakota (in 1972) and three in Saskatchewan (in 1971). With respect to human cases, outside Alaska, only 3 cases of alveolar echinococcosis are described that appear to have been acquired in North America; one in Manitoba (in 1937), one in Minnesota (in 1979), and one in Alberta (in 2014).

Information concerning *E. multilocularis* intestinal infections in dogs is contained in all veterinary parasitology textbooks; such infections can be readily eliminated by treatment with praziquantel. However, what is missing in almost every book is the fact that since the late 1980s, cases of alveolar echinococcosis, primarily involving the liver, have been described in dogs in Switzerland, Germany, France, and Belgium. These cases are thought to primarily occur as a result of ingestion of large numbers of eggs (see Figure 1) and typically have a poor prognosis.

Prior to 2009, alveolar echinococcosis had not been described in a dog in either Canada or the US. However, in 2009, a 3.5-year old shi tzu/bichon frisé cross-presented to a small animal practice in Powell River, BC, with a 10-day history of intermittent vomiting and lethargy. Palpation revealed a large firm mass in the cranial aspect of the abdomen. Ultrasound demonstrated a 12-13cm diameter hepatic mass with mixed echogenicity, cavitated lesions within, and an irregular surface. Exploratory laparotomy revealed a discrete multi-lobulated firm mass that appeared to originate in the left medial liver lobe, was firmly adherent to the stomach, the left lateral liver lobe, spleen and omentum. No abnormalities were detected in other abdominal organs. In total, a 570 g hepatic mass was resected that contained multiple coalescing white nodules that appeared to infiltrate adjacent hepatic tissue; at the time it was thought most likely to be a tumour (see Figure 2). Histologically, the mass contained multilocular cystic structures and multiple intraluminal protoscolices. DNA sequence data indicated that the mass was the intermediate stage of *E. multilocularis*. Following surgery, daily treatment with albendazole for life was recommended. Since the dog had never travelled outside BC, the infection must have been acquired within BC and constitutes the first diagnosis of *E. multilocularis* in that province.

In 2012, alveolar echinococcosis was diagnosed in a 2-year-old dog that resided in Niagara, southern Ontario; a second case was diagnosed in a 4-year-old dog that lived in Alberta and Manitoba. Between 2013 and 2015, three additional cases were diagnosed in dogs in southern Ontario; in Brantford, Burlington, and Guelph. In 2015, two non-human primates in southern Ontario were also diagnosed with alveolar echinococcosis. None of the eight animals had travelled outside Canada. All of the infections most likely occurred via ingestion of parasite eggs in the feces of wild canids. With respect to public health concerns, data from Europe indicate that some dogs with hepatic alveolar echinococcosis also have patent intestinal infections. Fortunately, to date, no human infections have been detected in association with any of these cases.

The occurrence of six cases of alveolar echinococcosis in southern Ontario since 2012 is a concern as *E. multilocularis* had not been diagnosed in the province prior to 2012. Furthermore, considering three of the four dogs and both non-human primates had lived their entire lives in southern Ontario, this suggests that *E. multilocularis* is now a common infection in wild canids across this region. As such, the parasite could be a significant threat to the health of a significant number of dogs and humans. In order to determine the true risk of infection in Ontario, a study is being conducted from 2015-2017 at the Ontario Veterinary College (OVC) to (i) Determine the prevalence of *E. multilocularis* in foxes and coyotes across southern Ontario, (ii) Identify high risk areas or “hot spots” for *E. multilocularis* infection in foxes and coyotes in this region, and (iii) Identify risk factors for *E. multilocularis* infection in foxes and coyotes. The resultant information will assist in the development of evidence-based recommendations to minimize the risk of infection in dogs and people. In addition, the findings will help veterinary and medical practitioners determine the likelihood of *E. multilocularis* infection in dogs and people, respectively, that present with clinical signs consistent with alveolar echinococcosis.

For additional information about the Ontario project, please contact Jonathan Kotwa, MSc student, OVC (tapewormstudy@gmail.com). Funding for this work has kindly been provided by Bayer Animal Health, the Ontario Animal Health Network, and the National Center for Veterinary Parasitology (US).

For information about similar work elsewhere in Canada, please contact Dr. Emily Jenkins at Western College of Veterinary Medicine (emily.jenkins@usask.ca) or Dr. Alessandro Massolo at the University of Calgary (amassolo@ucalgary.ca).

Andrew Peregrine obtained his DVM and PhD from the University of Glasgow, Scotland. He is a diplomate of the European Veterinary Parasitology College and the American College of Veterinary Microbiologists (Parasitology specialty). For the last 18 years he has taught clinical parasitology at the Ontario Veterinary College.

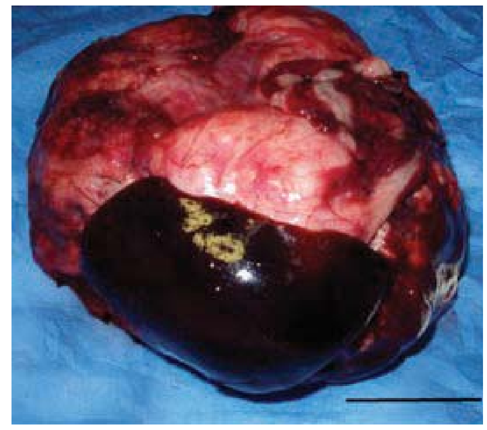

Figure 2: Resected hepatic mass from an adult shi tzu/bichon frisé cross dog with alveolar echinococcosis. The liver contains a multinodular mass with omental adhesions. Bar = 5 cm. (Original publication: Peregrine, A.S. Alveolar echinococcosis in dogs: an emerging issue? *The Veterinary Record* 2015;177:567-568. doi: 10.1136/vr.h6551; image by Brian Barnes).

Jon Kotwa is a masters of science candidate in the department of pathobiology at The University of Guelph. He is interested in both human and veterinary health. More specifically, his work examines Echinococcus multilocularis in Ontario.

Nutritional myths and misperceptions – part 2: Human-grade, organic, and natural ingredients, cats & carbohydrates

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Human-grade, organic, and natural ingredients

Ingredient-based marketing has become very prominent in pet foods recently. While it is legitimate that owners and veterinarians are informed about ingredients in the diet, it has led to some misinformation. In Canada, pet foods that are imported from or exported to the US must comply with The Association of American Feed Control Officials (AAFCO) definitions, but this is not the case for diets only sold within Canada.

Human-grade

"Human grade" ingredients have no official definition in animal feed regulations. However AAFCO has recently proposed that "human-grade" can only be used to describe the pet food as a whole, not individual ingredients, and as a consequence, every ingredient in the diet must respect manufacturing, packing, and holding standards set by federal regulations (USDA) to classify a food fit for human consumption. Using ingredients sourced from USDA-inspected plants does not necessarily mean that these ingredients are human-grade. Finally, human-grade ingredients or diets are not necessarily safer to pets: some human edible products can be toxic to dogs and cats (chocolate, onions, etc…), and petfood manufacturing can also follow high quality standards to ensure food safety.

Organic

As of February 2015, pet foods cannot be certified as organic in Canada under the Organic Product Regulations (OPR). However, "organic" ingredient claims can be seen on some pet foods imported from the US. They are legal only if the animal or plant ingredients in question have been produced through approved methods regulated by the USDA National Organic Program (NOP). To be claimed "organic" a diet must contain at least 95% organic ingredients. To date, there is no evidence that organic diets for cats or dogs are healthier, more nutritious, or safer.

Natural

Another term currently popular in the petfood industry is the word "natural", which is precisely defined by AAFCO. To be natural, an ingredient must be "*derived solely from plant, animal or mined sources, either in its unprocessed state or having been subject to physical processing, heat processing, rendering, purification, extraction, hydrolysis, enzymolysis or fermentation, but not having been produced by or subject to a chemically synthetic process and not containing any additives or processing aids that are chemically synthetic except in amounts as might occur in good manufacturing practices*". Therefore, 100% natural diets do not have added synthetic vitamins, minerals, amino acids, or preservatives. While this is possible, it is more complicated to achieve, hence the frequent label "*Natural with added vitamins, minerals, and trace nutrients*". It should be noted that some synthetic forms of nutrients are sometimes more bioavailable than natural forms (e.g. minerals chelated with amino acids), and that there is no published evidence that natural diets are healthier or safer for dogs and cats.

The website http://talkspetfood.aafco.org is a valuable resource for veterinarians and pet owners to better understand AAFCO rules regarding treats and pet foods.

Cats and carbohydrates

Unlike dogs, cats are true carnivores, and considerable attention has been paid in the last decade to their dietary regimen in connection with various disease processes. Dietary carbohydrate is probably one of the most controversial nutrients in that regard. Veterinarians must be able to sort out scientific information from marketing or popular misconceptions in order to make evidence-based recommendations. Dietary carbohydrates include simple (e.g. sugars), complex (e.g. starch) and indigestible (e.g. fibres) carbohydrates. In this article, the term carbohydrate will refer to carbohydrates that can be digested by the animal's enzymes, and assimilated.

Do cats need carbohydrate?

In the wild, the natural diet of cats contains less than 10% carbohydrate on a metabolizable energy (ME) basis (i.e. 10% of the total calories is provided by carbohydrates), while levels in commercial pet foods, especially dry diets, are typically around 20-35% ME (a minimum content is necessary to ensure starch gelatinization and cohesion of the kibble). Cats, like other mammalian species, require glucose to supply red blood cells, brain and nervous tissues, renal medulla, and other tissues with energy. However, cats can derive glucose not only from carbohydrate, but also from glucogenic amino acids. In fact, as strict carnivores, cats have metabolic adaptations that make them very efficient at processing high amounts of dietary protein and producing glucose from glucogenic amino acids. Therefore carbohydrate is not an essential nutrient in cats (nor in dogs). However, it remains a potentially important source of energy, and there is evidence that higher carbohydrate levels can enhance lactation in queens.