

Squirrel Fibroma Virus Infection in an Eastern Fox Squirrel (*Sciurus niger*) from Sangamon County, Illinois

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ABSTRACT

In April 2015, three eastern fox squirrels (*Sciurus niger*) were admitted to the Illinois Raptor Center in Decatur, Illinois, one of which developed lesions on its skin surface. We concluded that the lesions represented squirrel fibromatosis, caused by a squirrel fibroma virus (also known as squirrel pox virus; *Leporipox* genus) based on observation of initial lesion morphology, changes in lesion morphology over time, and histological analysis of the affected tissue. Though officially documented in grey squirrels from central Illinois and neighboring states, and in eastern fox squirrels in Michigan, we believe this to be the first documented case of squirrel fibroma virus in an eastern fox squirrel in Illinois.

Squirrel fibromatosis, which is the pathological manifestation of squirrel fibroma virus, was first reported in free-living squirrels in the United States in 1953 (Kilham et al. 1953). This initial documentation was in a small number of grey squirrels (*Sciurus carolinensis*) in Maryland. Since that time, multiple incidences of squirrel fibromatosis have been recorded throughout the United States, with the majority of infections occurring in grey squirrels, although fibromas have also been documented in eastern fox squirrels in Michigan (Cooley 1975). Transmission of squirrel fibroma virus is thought to occur primarily through direct contact with infected individuals and environmental sources such as shared cavities and cache sites; however, arthropod vectors are also known to transmit this pathogen from squirrel to squirrel (Collins et al. 2014). The virus-induced lesions, or fibromas, which are characteristic of severe infection, are caused by a poxvirus in the genus *Leporipox* (Terrell et al. 2002). The tumors caused by this pathogen appear as raised nodular lesions located primarily on the head and limbs of squirrels (Kilham et al. 1953, Terrell et al. 2002). In addition, histological analysis of the lesioned epidermal tissue typically reveals epidermal hyperplasia and epidermal fibroblast proliferation as well as the development of eosinophilic intracytoplasmic inclusion bodies (O'Connor et al. 1980). In otherwise healthy squirrels infected with squirrel pox, lesions may regress; however, if animals are in poor condition, the disease progresses to a point where the tumors overwhelm the body, particularly the eyes and nasal passages, lungs, and liver, the disease can be fatal (Thomas et al. 2003).

Three orphaned, male, neonate eastern fox squirrels were brought to the Illinois Raptor Center (IRC) in Decatur, Illinois on 7 April 2015. The IRC is a wildlife rehabilitation center at which rehabilitation efforts are primarily directed toward birds of prey; however, non-raptorial birds and small mammals are also occasionally admitted. The squirrels were found in Buffalo, Illinois (Sangamon County) on 4 April 2015, and with no observations of adult squirrels returning to the tree under which they were found, the squirrels were presumed orphaned and brought to the IRC. All three squirrels were severely emaciated, were not weaned, and were just starting to open their eyes, indicating they were approximately one month old. Each of the squirrels was fed milk and they were

housed together in an incubator at the IRC immediately after admission. Upon admission, one of the squirrels (IRC #15-035) was clearly weaker than the others, and was suffering from noticeable respiratory distress. Squirrel 15-035 died on 12 April 2015 with no signs of pox lesions. One of the squirrels (IRC #15-034) was admitted with swelling and subcutaneous nodules in the right ventral axillary region of the front leg (Fig. 1). During the subsequent six days of care, more nodules arose on squirrel 15-034, and on 13 April 2015, the nodules erupted, discharging a dense white pus and leaving large lesions. At this time, a tissue sample was collected from one of the lesions, applied to a microscope slide, fixed with methanol, and stained with Wright-Giemsa stain. The lesions on squirrel 15-034 began to heal; however, the squirrel struggled to put on weight, and died on 23 April 2015. The third squirrel (IRC #15-036), never showed signs of pox, was weaned during rehabilitation, but regressed quickly in late May and died prior to release.

In addition to the epidermal lesions, microscopic analysis of the lesion tissue from squirrel 15-034 revealed eosinophilic intracyto-



Figure 1. Epidermal nodules on a neonate eastern fox squirrel from Sangamon County, IL upon admission to the Illinois Raptor Center. The nodules eventually ruptured and progressed to lesions.

plasmic inclusion bodies consistent with those seen in squirrel pox infection (Fig. 2). In addition, the vast majority of erythrocytes in the sample were also crenated (abnormally shaped, echinocytes, or burr cells, Fig. 2), which is suggestive of acute hepatic necrosis or uremia, either condition, which could indicate that the poxvirus was impacting the liver. Given that this squirrel died despite the extensive care and rigorous rehabilitation efforts, the inability to maintain viable red blood cells would certainly lead to death in even these good conditions.

Though one case of squirrel pox is by no means indicative of a large-scale epizootic risk, it is worth noting that in other species, in different geographic locations, this pathogen has reached epizootic proportions. In 2014, three orphaned grey squirrels were admitted and diagnosed with squirrel fibroma virus (squirrel pox) at the Wildlife Medical Clinic at the University of Illinois (Rivas et al. 2014). The grey squirrels treated at the Wildlife Medical Clinic were found approximately 75 miles from where the eastern fox squirrels described in our study were found. Many other singular or small-scale incidents of squirrel pox have been reported from North America and Europe (e.g. Kilham et al. 1953, Cooley et al. 1975, King et al. 1972; Himsworth et al. 2009). Fibromatosis was observed in hundreds of gray squirrels (*Sciurus carolinensis*) in seven counties on the east coast of peninsular Florida in an epizootic lasting from Fall 1998 to early Summer 1999 (Terrell et al. 2002). In a case far more severe than the aforementioned Florida epizootic, invasive grey squirrels in the United Kingdom are rapidly displacing native red Squirrels (*Sciurus vulgaris*), a phenomenon which is partially attributed to squirrel pox virus. The disease is typically fatal to red squirrels, but not to grey squirrels, and the ecological replacement of red squirrels by grey squirrels is up to 25 times faster where the virus is present (Collins et al. 2014). In a laboratory experiment with red squirrels given ad libitum food

and otherwise free of environmental pressures, the mortality rate of squirrels infected with squirrel fibroma virus was 75% (Tompkins et al. 2002). Though similar studies have not been conducted with grey squirrels, field studies of seroprevalence of squirrel fibroma virus in free-living populations paired with population trends suggest that this virus has a negligible impact on survival rates of grey squirrels.

We believe this to be the first reported case of squirrel pox virus in an eastern fox squirrel in Illinois. Although this case represents a single squirrel, it is important to continually monitor squirrel populations for increasing prevalence given the short history of devastating effects of this disease in squirrel populations elsewhere.

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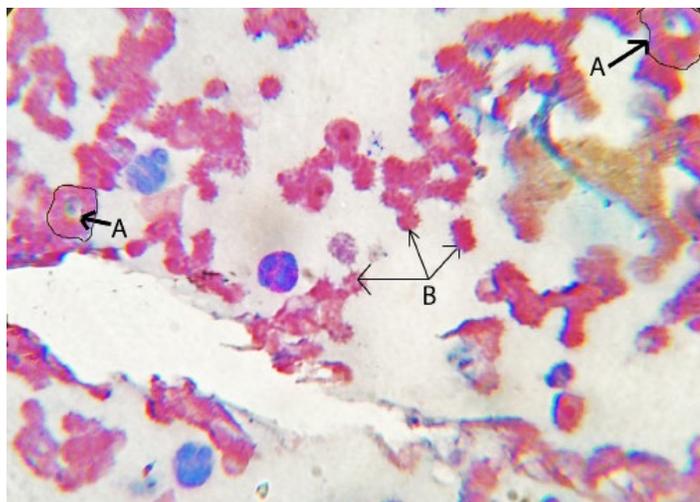


Figure 2. Histological evidence of squirrel pox virus in an Eastern Fox Squirrel. This tissue sample was collected from one of the lesion sites, stained with Wright-Giemsa stain and viewed at 100x magnification. The eosinophilic intracytoplasmic inclusion bodies are identified by arrows and marked with the letter A, with the cells encircled with a black outline. Crenated erythrocytes are identified by arrows and the letter B.