

2019

## Occurrence of the Sinus Nematode *Skrjabingylus* sp. (Nematoda: Metastrongyloidea) Inferred from Sinus Lesions in Arkansas Mustelidae and Mephitidae, with review of relevant literature

C. Renn Tumlison

*Henderson State University*, [tumlison@hsu.edu](mailto:tumlison@hsu.edu)

Terry Tumlison

Follow this and additional works at: <https://scholarworks.uark.edu/jaas>



Part of the [Biology Commons](#), and the [Ecology and Evolutionary Biology Commons](#)

---

### Recommended Citation

Tumlison, C. Renn and Tumlison, Terry (2019) "Occurrence of the Sinus Nematode *Skrjabingylus* sp. (Nematoda: Metastrongyloidea) Inferred from Sinus Lesions in Arkansas Mustelidae and Mephitidae, with review of relevant literature," *Journal of the Arkansas Academy of Science*: Vol. 73 , Article 5.

DOI: <https://doi.org/10.54119/jaas.2019.7322>

Available at: <https://scholarworks.uark.edu/jaas/vol73/iss1/5>

This article is available for use under the Creative Commons license: Attribution-NoDerivatives 4.0 International (CC BY-ND 4.0). Users are able to read, download, copy, print, distribute, search, link to the full texts of these articles, or use them for any other lawful purpose, without asking prior permission from the publisher or the author.

This Article is brought to you for free and open access by ScholarWorks@UARK. It has been accepted for inclusion in *Journal of the Arkansas Academy of Science* by an authorized editor of ScholarWorks@UARK. For more information, please contact [scholar@uark.edu](mailto:scholar@uark.edu).

---

**Occurrence of the Sinus Nematode *Skrjabingylus* sp. (Nematoda: Metastrongyloidea) Inferred from Sinus Lesions in Arkansas Mustelidae and Mephitidae, with review of relevant literature**

**Cover Page Footnote**

Acknowledgements We thank Thomas Risch and Tracy Klotz (ASU), and Robert Sikes and William Baltosser (UALR) for access to collections of mammals at their institutions.

# Occurrence of the Sinus Nematode *Skrjablingylus* sp. (Nematoda: Metastrongyloidea) Inferred from Sinus Lesions in Arkansas Mustelidae and Mephitidae, with Review of Relevant Literature

R. Tumilson<sup>1\*</sup> and T. L. Tumilson<sup>2</sup>

<sup>1</sup>Department of Biological Sciences, Henderson State University, Arkadelphia, AR, 71999

<sup>2</sup>367 Mt. Zion Rd., Arkadelphia, AR 71923

\*Correspondence: tumilson@hsu.edu

Running Title: Sinus Nematodes in Arkansas Mustelidae and Mephitidae

## Abstract

Nasal nematodes of the genus *Skrjablingylus* occur in the mammalian families Mustelidae and Mephitidae, and in North America occur from Canada to Costa Rica. Ingestion of infected snails, frogs, snakes, or mice can infect mammalian hosts. Infection often causes pathology to bones in the sinus region, which may lead to discoloration, enlargement, and fenestrations of the bone. Examination of museum specimens for evidence of infection has been used to detect prior infection, but prevalence and intensity cannot be interpreted without actually recovering the parasite. We examined Mustelids and Mephitids in collections of mammals housed at Arkansas State University (ASU), Henderson State University (HSU), and the University of Arkansas at Little Rock (UALR) to evaluate the possible occurrence of nasal nematodes in Arkansas mammals. Evidence of infection was found in skulls of the Striped Skunk (*Mephitis mephitis*), Spotted Skunk (*Spilogale putorius*), Mink (*Neovison vison*), Long-tailed Weasel (*Mustela frenata*), and North American River Otter (*Lontra canadensis*) from Arkansas. We report for the first time evidence of the presence and distribution of *Skrjablingylus* sp. infecting mammals in Arkansas.

## Introduction

The trematode *Troglorema acutum* and species of the nematode *Skrjablingylus* can cause cranial lesions in skulls of certain mammals (Heddergott *et al.* 2015a), but *T. acutum* occurs only in Europe so does not affect New World mammals. In North and Central America, only nasal nematodes of the genus *Skrjablingylus* have been identified from several geographic locations and in several members of the mammalian families Mustelidae and Mephitidae. Records are known from as far north as the Northwest Territories of Canada (Dougherty and Hall 1955) to as far south as Costa Rica (Carreno *et al.*

2005). The infective third stage larvae of *Skrjablingylus* may be ingested when a host species consumes an intermediate host (such as snails) or consumes paratenic hosts such as frogs, snakes, or mice (Lankester and Anderson 1971; Hansson 1967; Gamble and Riewe 1982; Jennings *et al.* 1982; Weber and Mermod 1985).

*Skrjablingylus nasicola* is the most widely distributed species of the genus (Santi *et al.* 2006), and is common and cosmopolitan. The definitive hosts of *S. nasicola* are members of the genus *Mustela* (then including mink, which is now in the genus *Neovison*) (Hawkins *et al.* 2010). Other species of *Skrjablingylus* appear also to have host specificity; *S. petrowi* of the genus *Martes* (Heddergott *et al.* 2015b), *S. chitwoodorum* of the skunks *Mephitis* and *Spilogale* (Hill 1939, Hobmaier 1941; Goble 1942), and *S. lutrae* of river otters (Lankester and Crichton 1972).

In mink, up to 63 worms were counted in an individual from Minnesota (Kinsey and Longley 1963), but the average infection was 4.1 worms per cavity in Ontario (Santi *et al.* 2006). Significant infection often causes bone pathologies of the sinus region, which may present as discoloration, swelling or enlargement, and fenestrations of bone in the region of the sinuses (Santi *et al.* 2006). Lesions, known as local rarefying osteomyelitis, result from a reaction to the worms in the sinuses, which eventually can result in damage to bone (Kierdorf *et al.* 2006). Significance of the infection, suggested by hypotheses of a relatively smaller braincase caused by swelling of the frontal sinuses in older, infected animals, was supported for striped skunks (*Mephitis mephitis*) (Maldonado and Kirkland 1986), older male mink (Bowman and Tamlin 2007), and also occurred with a bias toward males in river otters (Scherr and Bowman 2009).

## Methods

Because no data exist about occurrence of

## Sinus Nematodes in Arkansas Mustelidae and Mephitidae

*Skrjabinogylus* in Arkansas, we sought to determine which Arkansas members of the Mustelidae and Mephitidae might show evidence of infection. We examined skulls housed in collections of mammals at Arkansas State University (ASU), Henderson State University (HSU), and the University of Arkansas at Little Rock (UALR). We examined skulls of the Striped Skunk (*Mephitis mephitis*), Spotted Skunk (*Spilogale putorius*), Mink (*Neovison vison*), Long-tailed Weasel (*Mustela frenata*), and North American River Otter (*Lontra canadensis*), all of the members of the Mustelidae and Mephitidae in Arkansas with the exception of the American Badger (*Taxidea taxus*). We collected data regarding the county of origin of each specimen to examine distribution within Arkansas.

## Results and Discussion

The apparent oldest skull from Arkansas exhibiting damage from infection with *Skrjabinogylus* was a new subspecies of ermine named by Brown (1908) after collection from the Conard Fissure in Newton County. Originally named *Putorius cicognanii angustidens*, and now known as *Mustela erminea angustidens*, one specimen shown in plate XVII of Brown (1908) had a circular lesion on the left side just behind the postorbital process of the skull. The lesion is consistent with infection by *Skrjabinogylus*.

In the modern species we examined, we detected lesions in all species. Skulls of smaller species appeared to be more likely to demonstrate lesions, and to have larger openings, likely due to the thinner bones constituting the frontal region. Bones of the North American River Otter are more substantive, and were deemed less likely to show lesions (Scherr and Bowman 2009).

Examination of museum specimens for bone pathologies in the sinuses often has been used to provide evidence of occurrence, prevalence, and intensity of infection. Stegeman (1939) found bone lesions in New York *Mephitis* and suggested infection by *Skrjabinogylus*, and Tiner (1946) used occurrence of lesions to infer the presence of this nematode in Texas skunks. Reliance on observation of damage in museum specimens to determine prevalence and intensity of infection have added confusion, however, due to problems in inferring levels of parasite burden without actually recovering the parasite (Dougherty and Hall 1955).

Presence or absence of osteological damage may not be a good index of the incidence of these parasites. Goble and Cook (1942) examined the sinuses of 10

minks and 10 weasels and found infections in 4 of each species, but no external enlargement or abnormality was observed. On the other hand, they found no worms on opening the sinuses of a Bonaparte weasel that had an enlarged frontal region. Levine *et al.* (1962) also reported that these parasites were present in the brain cases of skunks that did not show the characteristic lesions. Thus, damage in the sinuses may indicate that infection has occurred, but not that it is current, and absence of damage does not mean no infection is present.

Considerable variation exists with respect to reported patterns of occurrence and manifestation of infection. Several studies report evidence that both prevalence and intensity of infection tend to be higher in older host animals (Dougherty and Hall 1955; Gamble and Riewe 1982; Fuller and Kuehn 1984), but other studies find this in juveniles (Santi *et al.* 2006). Both prevalence and intensity of infection were observed to be higher in male ermine (Dubay *et al.* 2014), and male otters were found to suffer greater damage to their skulls due to these parasites (Scherr and Bowman 2009). Skulls of male Least Weasels (*Mustela nivalis*) were more severely damaged in England (King 1977), as were skulls of male Long-tailed Weasels (*Mustela frenata*) in Manitoba (Gamble and Riewe 1982). In contrast, Debrot and Mermod (1980) reported no sex- or age-related differences in mustelids from Switzerland. Santi *et al.* 2006 summarized studies in which an infection bias to one sinus was believed to have caused asymmetrical damage to the sinus region, whereas other studies found no difference in damage between the sinuses (Hansson 1967; Lewis 1967).

Therefore, we present data only to demonstrate the inferred presence of the nematode in mustelids and mephitids from Arkansas, the distribution of such occurrences, and relevant literature to elucidate how our observations fit with other North American information.

**Spotted Skunk (*Spilogale putorius*)** - Hill's (1939) description of a new species of sinus nematode, *Skrjabinogylus chitwoodorum*, was based partly on specimens collected from *Spilogale interrupta* collected in Oklahoma. In California, *S. chitwoodorum* was reported to occur frequently in spotted skunks taken from the Davis area (Mead 1963). Lesions assumed to have been caused by an infestation by *S. chitwoodorum* were found in skulls of 3 *Spilogale* from Texas, wherein damage varied from bulging and osteitis to holes in the frontal sinuses (Tiner 1946).

Spotted Skunks are not well represented in collections in Arkansas. We examined 5 specimens,

originating from Franklin, Izard, Pulaski, and Sebastian Counties. Those from Franklin, Pulaski and Sebastian Counties, showed evidence of infection (Fig. 1). The Pulaski Co. specimen had a small hole in the right sinus, the Sebastian Co. specimen had a large hole on the left sinus, and the Franklin Co. specimen had 2 holes in the right sinus (see Fig. 1).



Figure 1. Skulls of the Spotted Skunk (*Spilogale putorius*) from Arkansas, showing significant sinus lesions creating large holes due to infestation by *Skrjabinigylus* sp. Top image shows two large holes in the right sinus, and bottom image is a large hole in the left sinus of a different specimen.

**Striped Skunk (*Mephitis mephitis*)** – Stegeman (1939) noted skull lesions attributable to *Skrjabinigylus* parasitism in skunks from New York, and Hill (1939) described *Skrjabinigylus chitwoodorum*, based on specimens collected from skunks (*Mephitis* and *Spilogale*) in Oklahoma. Goble (1942) reported *S. chitwoodorum* from *Mephitis* near Schenectady, NY, Tiner (1946) reported lesions attributed to this parasite in 3 *Mephitis* skulls from Texas, Levine *et al.* (1962) reported them in Illinois, and Bailey (1971) recorded them in Ohio. Dyer (1969) listed records of *S. chitwoodorum* in *Mephitis* from Maryland, Illinois, California, Kansas, and Quebec. Carreno *et al.* (2005) described *Skrjabinigylus santaceciliae* based on specimens from a hooded skunk, *Mephitis macroura* from Costa Rica.

We examined 94 skulls of Striped Skunks, of which 5 (5.3%) showed lesions. Manifestations of infection included swollen discolored sinuses, a swollen bubbly

appearance with tiny perforations, numerous small perforations, and a remodeled forehead with a high rise ridge (Fig. 2). Specimens originated from 26 counties, and 5 counties were represented by lesioned skulls (Fig. 5).



Figure 2. Skulls of the Striped Skunk (*Mephitis mephitis*) from Arkansas, showing significant sinus lesions due to infestation by *Skrjabinigylus* sp. Top, the bubbly appearance resulting from swelling and tiny perforation; middle, numerous small perforations; bottom, swelling with considerable bone restructuring.

**American Mink (*Neovison vison*)** – The American Mink is a common mustelid of North America. Heavily infected specimens often exhibit inflated, discolored, and perforated sinuses (Sealander 1943, Kinsey and Longley 1963), though infections may occur with no visible manifestations (Goble and Cook 1942). In Minnesota, up to 63 worms were counted in an individual mink (Kinsey and Longley 1963).

Our mink sample originated from 15 counties, and specimens with damage caused by *Skrjabinigylus* came

## Sinus Nematodes in Arkansas Mustelidae and Mephitidae

from 8 counties (Fig. 6). Of 94 specimens we examined, 51 (54.3%) showed evidence of infection (Fig. 3). Prevalence of infection by *S. nasicola* in mink appears to be generally high throughout North America. Sealander (1943) found *Skrjabinogylus* to be the most common parasite of mink in Michigan, occurring in 94% of specimens. Goble and Cook (1942) found 40% infection in New York, Dorney and Lauerman (1969) found 85% infection in Wisconsin, and Kinsey and Longley (1963) reported 75% infection in Minnesota. Santi *et al.* (2006) reported that 80.5% of mink were infected in Ontario, whereas Schulte-Hostedde and Elsasser (2011) reported infection in 43.6% of male mink in Ontario.

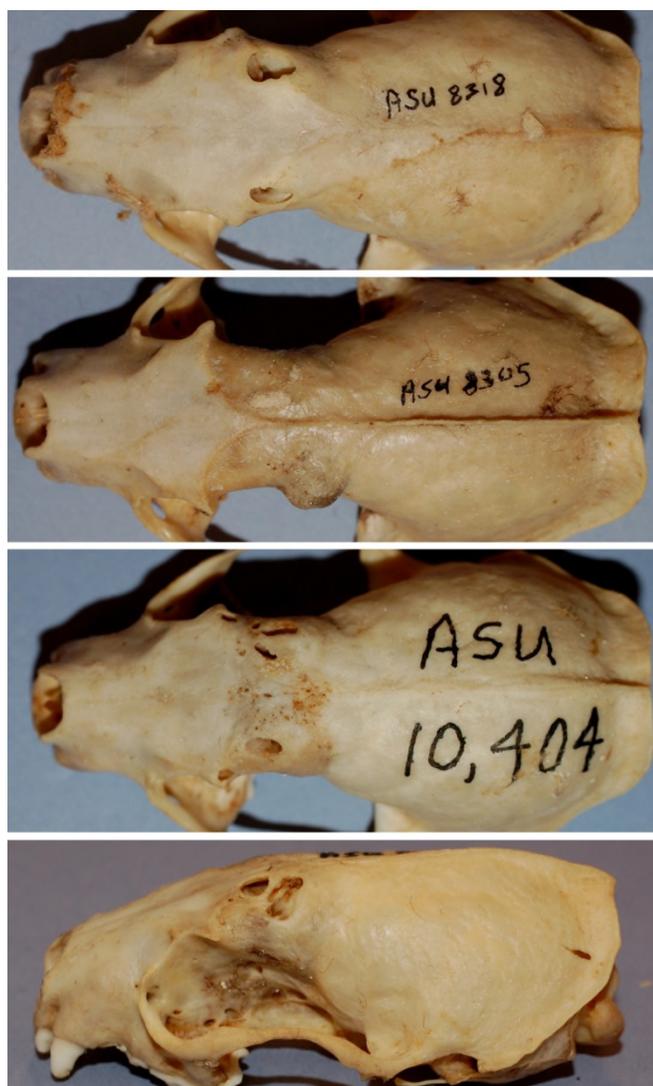


Figure 3. Skulls of American Mink (*Neovison vison*) from Arkansas, showing significant sinus lesions due to infestation by *Skrjabinogylus* sp. Top, bilateral presentation of large holes: second from top, bulge in left sinus; third, bubbly appearance with bilateral large holes; and bottom, left sinus with 2 large holes.

The higher numbers of infected specimens allowed us to examine occurrence in more detail than for other species examined. Infections were represented bilaterally (in both sinuses) in 78.4% of the specimens. Santi *et al.* (2006) reported that a higher proportion of mink (58.2%) from Ontario were infected in both sinus cavities concurrently (double sinus infection), but frequency or intensity of infection did not differ significantly between left and right sinus cavities.

We ranked nature of infection for each side of each specimen according to the degree of damage, classifying based on the highest level of damage. Evidence of infection ranged from discoloration only (14.7% of sinuses), to a bubbly appearance with tiny holes (18.9%), small holes (< 2 mm; 33.7%), medium holes (2-4 mm; 15.8%), and large holes (> 4 mm, or 2 or more medium-sized holes; 16.8%). Sinuses with holes could also have a bubbly texture, and be discolored (Fig. 3). Our infected specimens originated from 8 counties (Fig. 6).

High frequencies of infection may have a yet unknown effect on behavior. Bowman and Tamlin (2007) found that infection with *Skrjabinogylus* in older male mink caused down-warping of the braincase, resulting in reduced braincase volume caused by swelling of the frontal sinuses.

**Long-tailed Weasel (*Mustela frenata*)** – Goble and Cook (1942) found *Skrjabinogylus* infections in 4 weasels, though they had caused no external enlargement or abnormalities in the skull. Clapp (1952) reported *S. nasicola* in Long-tailed Weasels from Oregon, where up to 14 individuals were taken from 1 specimen.

Long-tailed weasels are not collected often in Arkansas, and our sample consisted of only 2 specimens, from Bradley and Craighead Counties. The weasel collected in Craighead Co. had a small hole resulting from infection of the right sinus.

**North American River Otter (*Lontra canadensis*)** – Lankester and Crichton (1972) described *Skrjabinogylus lutrae* from river otters in Ontario. We examined 188 skulls of river otters from Arkansas, of which 16 (8.5%) showed lesions. Because skulls of otters are more robust than those of other hosts, it is less likely that they will show lesions. Most of our affected specimens presented discoloration, swelling, and small openings, but 1 specimen had a relatively large hole (4 mm) on the left sinus (Fig. 4). Our sample originated from 31 counties, of which 10 produced specimens infected by *Skrjabinogylus* (Fig. 7).

Otters may harbor many *S. lutrae* and have major skull lesions without showing obvious clinical disease (Addison *et al.* 1988), but other infected otters have nasal discharge and neurologic signs (Petrini 1992). However, Scherr and Bowman (2009) found that skulls of male otters lesioned by infection also had reduced braincase volume, and to a lesser extent, female otters were similarly affected. This might affect behavior and survival of otters.

## Conclusions

Through sinus lesions attributed to infection by the nasal nematode *Skrjabingylus*, we document the inferred occurrence of this parasite in the Mustelidae and Mephitidae of Arkansas. If host specificity is absolute, we have *S. nasicola* in Long-tailed Weasels and American Mink, *S. chitwoodorum* in Striped and Spotted Skunks, and *S. lutrae* in North American River Otters. We believe these parasites occur throughout the distribution of their hosts in Arkansas.



Figure 4. Skulls of North American River Otter (*Lontra canadensis*) from Arkansas, showing significant sinus lesions due to infestation by *Skrjabingylus* sp

## Acknowledgments

We thank Thomas Risch and Tracy Klotz (ASU), and Robert Sikes and William Baltosser (UALR) for access to collections of mammals at their institutions.

## Literature Cited

- Addison EM, MA Strickland, AB Stephenson, and J Hoeve.** 1988. Cranial lesions possibly associated with *Skrjabingylus* (Nematoda: Metastrongyloidea) infection in martens, fishers, and otters. *Canadian Journal of Zoology* 66:2155-2159.
- Bailey TN.** 1971. Biology of striped skunks on a southwestern Lake Erie marsh. *American Midland Naturalist* 85:196-207.
- Bowman J and AL Tamlin.** 2007. The effect of sinus nematode infection on braincase volume and cranium shape in the mink. *Journal of Mammalogy* 88:946-950.
- Brown B.** 1908. The Conard Fissure, a Pleistocene bone deposit in northern Arkansas: with descriptions of two new genera and twenty new species of mammals. *Memoirs of the American Museum of Natural History* 9:157-208.
- Carreno RA, KE Reif, and SA Nadler.** 2005. A new species of *Skrjabingylus* Petrov, 1927 (Nematoda: Metastrongyloidea) from the frontal sinuses of the Hooded Skunk, *Mephitis macroura* (Mustelidae). *Journal of Parasitology* 91:102-107.
- Clapp RL.** 1952. A new host and distribution record for the nematode parasite, *Skrjabingylus nasicola* (Leuckart 1842). *Journal of Parasitology* 38:185.
- Debrot S and C Mermod.** 1980. Cranial helminth parasites of the stoat and other mustelids in Switzerland. In: Chapman JA and D Pursley, editors. *Proceedings of the Worldwide Furbearer Conference, Vol. 2.* College Park (MD): University of Maryland Press. p. 690-705.
- Dorney RS and LH Lauerman Jr.** 1969. A helminthological survey of wild mink in Wisconsin. *Bulletin of the Wildlife Disease Association* 5:35-36.
- Dougherty EC and ER Hall.** 1955. The biological relationships between American weasels (genus *Mustela*) and nematodes of the genus *Skrjabingylus* Petrov, 1927 (Nematoda: Metastrongylidae), the causative organisms of certain lesions in weasel skulls. *Revista Iberica de Parasitologia* 15:531-576.

## Sinus Nematodes in Arkansas Mustelidae and Mephitidae

- Dubay S, MJ Buchholz, R Lisiecki, T Huspeni, T Ginnett, L Haen, and P Borsdorf.** 2014. Prevalence and intensity of nematode parasites in Wisconsin ermine. *Journal of Parasitology* 100:616-622.
- Dyer WG.** 1969. Helminths of the striped skunk, *Mephitis mephitis*, in North America. *American Midland Naturalist* 82:601-605.
- Fuller TK and DW Kuehn.** 1984. *Skrjabinogylus chitwoodorum* (Hill, 1939) (Nematoda: Metastrongyloidea) in striped skunks from Northcentral Minnesota. *Journal of Wildlife Disease* 20:348-350.
- Gamble RL and RR Riewe.** 1982. Infestations of the nematode *Skrjabinogylus nasicola* (Leuckart 1842) in *Mustela frenata* (Lichenstein) and *M. erminea* (L.) and some evidence of a paratenic host in the life cycle of this nematode. *Canadian Journal of Zoology* 60:45-52.
- Goble FC.** 1942. *Skrjabinogylus chitwoodorum* from the frontal sinuses of *Mephitis nigra* in New York. *Journal of Mammalogy* 23:96-97.
- Goble FC and AH Cook.** 1942. Notes on nematodes from the lungs and frontal sinuses of New York furbearers. *Journal of Parasitology* 28:451-455.
- Hansson I.** 1967. Transmission of the parasitic nematode *Skrjabinogylus nasicola* (Leuckart 1842) to species of *Mustela* (Mammalia). *Oikos* 18:247-252.
- Hawkins CJ, P Stuart, M Heddergott, and C Lawton.** 2010. Sinus worm (*Skrjabinogylus nasicola* (Leuckart, 1842)) infection in American mink (*Mustela vison* Schreber, 1777) in Ireland. *The Irish Naturalists' Journal* 31:108-112.
- Heddergott M, AC Frantz, J Jenrich, and F Müller.** 2015a. Dissections of fresh skulls confirm low prevalence of *Troglostrongylus acutum* (Trematoda: Troglostrongylidae) in German badgers (*Meles meles*). *Parasitology Research* 114:789-793.
- Heddergott M, F Müller, and AC Frantz.** 2015b. Prevalence and molecular identification of the sinus worms *Skrjabinogylus petrowi* (Nematoda: Metastrongyloidea) from *Martes* spp. in Germany. *Parasitology Research* 114:2053-2061.
- Hill WC.** 1939. The nematode *Skrjabinogylus chitwoodorum* n. sp. from the skunk. *Journal of Parasitology* 25:475-478.
- Hobmaier M.** 1941. Extramammalian phase of *Skrjabinogylus chitwoodorum* (Nematoda). *Journal of Parasitology* 27:237-239.
- Jennings DH, W Threlfall, and DG Dodds.** 1982. Metazoan parasites and food of short-tailed weasels and mink in Newfoundland, Canada. *Canadian Journal of Zoology* 60:180-183.
- Kierdorf U, H Kierdorf, D Kanjevic, and P Lazar.** 2006. Remarks on cranial lesions in the European polecat (*Mustela putorius*) caused by helminth parasites. *Veterinarski Arhiv* 76:S101-S109.
- King CM.** 1977. The effects of the nematode parasite *Skrjabinogylus nasicola* on British weasels (*Mustela nivalis*). *Journal of Zoology* 182:225-249.
- Kinsey C and WH Longley.** 1963. Incidence of *Skrjabinogylus* in Minnesota mink. *Journal of Mammalogy* 44:261.
- Lankester MW and RC Anderson.** 1971. The route of migration and pathogenesis of *Skrjabinogylus* spp. (Nematoda: Metastrongyloidea) in Mustelids. *Canadian Journal of Zoology* 49:1283-1293.
- Lankester MW and VJ Crichton.** 1972. *Skrjabinogylus lutrae* n. sp. (Nematoda: Metastrongyloidea) from otter (*Lutra canadensis*). *Canadian Journal of Zoology* 50:337-340.
- Levine ND, V Ivens, TRB Barr, and BJ Verts.** 1962. *Skrjabinogylus chitwoodorum* (Nematoda: Metastrongylidae) in skunks in Illinois. *Transactions of the Illinois Academy of Science* 55:3-5.
- Lewis JW.** 1967. Observations on the skull of Mustelidae infected with the nematode, *Skrjabinogylus nasicola*. *Journal of Zoology* 153:561-564.
- Maldonado JE and GL Kirkland, Jr.** 1986. Relationship between cranial damage attributable to *Skrjabinogylus* (Nematoda) and braincase capacity in the striped skunk (*Mephitis mephitis*). *Canadian Journal of Zoology* 64:2004-2007.
- Mead RA.** 1963. Some aspects of parasitism in skunks of the Sacramento Valley of California. *American Midland Naturalist* 70:164-167.
- Petrini K.** 1992. The medical management and diseases of mustelids. In: Junge RE, editor. *Proceedings of the Joint Meeting, American Association of Zoo Veterinarians and American Association of Wildlife Veterinarians*. p. 116-135.
- Santi SA, GH Parker, NP Schaffner, L Capodagli, and MA Persinger.** 2006. Prevalence, intensity, and geographic distribution of sinus worm (*Skrjabinogylus nasicola*) infection in mink (*Mustela vison*) of central Ontario. *Canadian Journal of Zoology* 84:1011-1018.
- Scherr H and J Bowman.** 2009. A sex-biased effect of parasitism on skull morphology in river otters. *Ecoscience* 16:119-124.

**Schulte-Hostedde AI and SC Elsasser.** 2011. Spleen mass, body condition, and parasite load in male American mink (*Neovison vison*). *Journal of Mammalogy* 92:221-226.

**Sealander JA.** 1943. Notes on some parasites of the mink in southern Michigan. *Journal of Parasitology* 29:361-362.

**Stegeman LC.** 1939. Some parasites and pathological conditions of the skunk (*Mephitis mephitis nigra*) in central New York. *Journal of Mammalogy* 20:493-496.

**Tiner JD.** 1946. Some helminth parasites of skunks in Texas. *Journal of Mammalogy* 27:82-83.

**Weber JM and C Mermod.** 1985. Quantitative aspects of the life cycle of *Skrjabingylus nasicola*, a parasitic nematode of the frontal sinuses of mustelids. *Zeitschrift Parasitenkunde* 71:631-638.

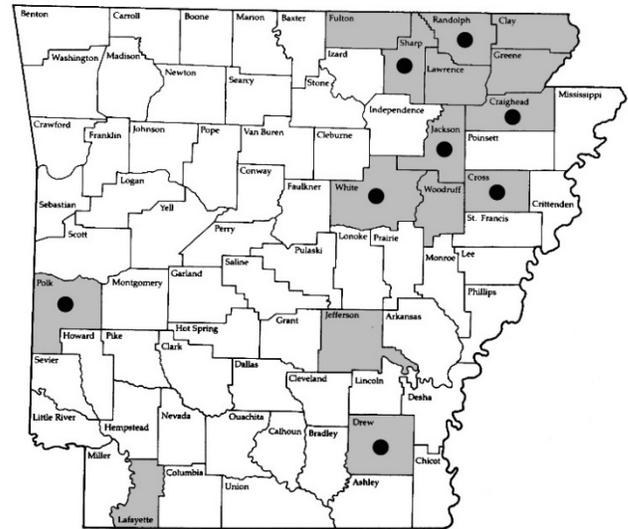


Figure 6. Distribution of Mink (*Neovison vison*) in the sample (gray-shaded counties) and occurrence of lesions caused by *Skrjabingylus* sp. (dots). Counties with infected Mink included Cross, Craighead, Drew, Jackson, Polk, Randolph, Sharp, and White.

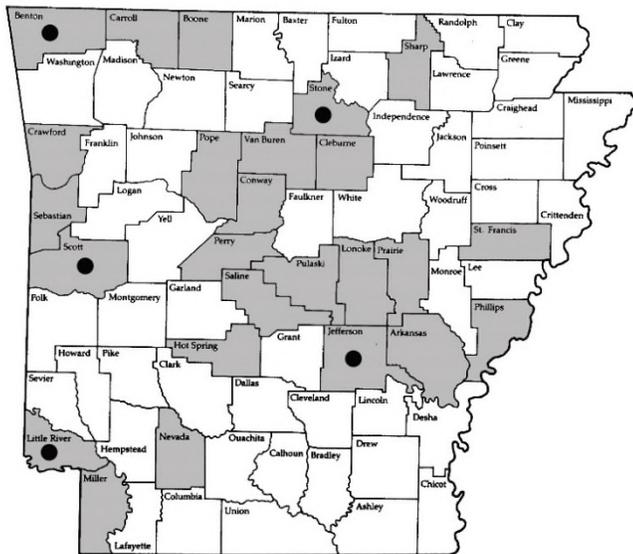


Figure 5. Distribution of Striped Skunks (*Mephitis mephitis*) in the sample (gray-shaded counties) and occurrence of lesions caused by *Skrjabingylus* sp. (dots). Counties with infected Striped Skunks included Benton, Jefferson, Little River, Scott, and Stone.

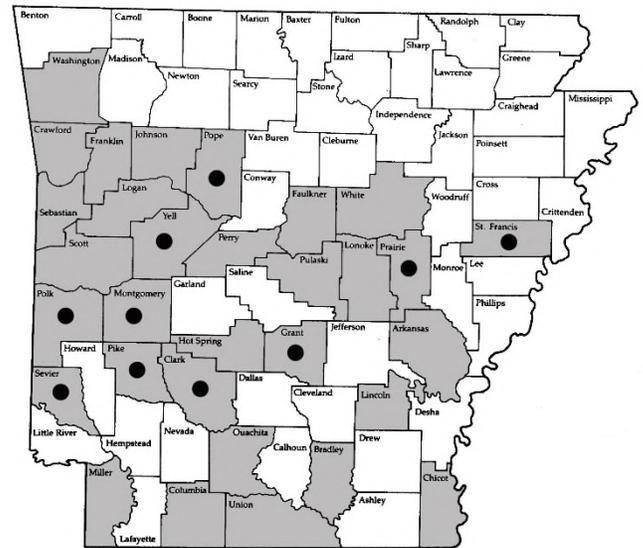


Figure 7. Distribution of River Otters (*Lontra canadensis*) in the sample (gray-shaded counties) and occurrence of lesions caused by *Skrjabingylus* sp. (dots). Counties with infected otters included Clark, Grant, Montgomery, Pike, Polk, Pope, Prairie, Sevier, St. Francis, and Yell.