Knemidocoptiasis in a pine grosbeak (*Pinicola enucleator*)

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History

An adult, male 74-g (0.2-lb) pine grosbeak (*Pinicola enucleator*) with crusts on its legs was found dead under a window in November, 2015 in Galena, AK. The Alaska Department of Fish and Game reported higher than average numbers of pine grosbeaks in the area during the winter, some of which were observed with similar crusts.

Gross Findings

On external examination, bilaterally, yellow, raised, nodular crusts encircled the tarsometatarsi and were present on the cranial and lateral aspects of the tibiotarsi (Fig. 1A & Fig. 1B). Metatarsals were not affected. There was a moderate amount of subcutaneous, visceral, and epicardial fat indicative of good body condition. The proventriculus and ventriculus contained a large amount of sunflower seeds. Hemorrhages, consistent with trauma from a window strike, were observed in the oral cavity, tracheal lumen, lungs, liver and distal intestines.

Histopathologic, Parasitological and Molecular Findings

There was locally extensive, severe orthokeratotic hyperkeratosis of the cranial tibiotarsus. Throughout the stratum corneum, there were clear spaces that often contained sections of mites or their eggs (Fig. 2A). Mites were approximately 300 µm wide with an eosinophilic exoskeleton with spines, a hemocoel, striated muscle, and jointed appendages (Fig. 2B). Eggs measured approximately 25 µm in diameter (Fig. 2C). Skin scrapings from the leg identified greater than 150 *Knemidocoptes* spp. that were morphologically similar to *K. jamaicensis* (Fig. 2D & Fig. 2E).[1,2] We isolated mites from frozen leg tissue,[3] extracted DNA and performed PCR to amplify the cytochrome oxidase subunit I gene using the methods of Dabert et al.[4] with elimination of overnight pre-incubation. A 700 base-pair PCR fragment was

visualized on a 0.1% agarose gel, and DNA was sequenced at the University of Wisconsin at Madison Biotechnology Center (Madison, Wisconsin, USA) using the BigDye Terminator v3.1 (Applied Biosystems, Foster City, CA, USA) DNA sequencing system, deposited in GenBank (accession number MF043583), and used in the Blast Local Alignment Search Tool[5] aligner to interrogate GenBank at the National Center for Biotechnology Information sequence database. The amplified sequence was most closely related to *Knemidocoptes jamaicensis* (GenBank JQ037816.1; 88%).

Morphologic Diagnosis and Case Summary

Morphologic diagnosis: proliferative dermatitis, multifocal, severe, chronic with orthokeratotic hyperkeratosis and intracorneal mites consistent with *Knemidocoptes* spp.

Case summary: proliferative dermatitis caused by *Knemidocoptes jamaicensis* in a pine grosbeak.

Comments

Mites that parasitize the skin of birds are found within the families Epidermoptidae and Dermationidae. While most species in these families only parasitize the surface of the skin, mites in the family Epidermoptidae, subfamily Knemidocoptinae bury deep into the skin of their hosts causing disease similar to mange.[6] Genera within Knemidocoptinae include *Knemidocoptes*, *Neocnemidocoptes*, *Procnemidocoptes*, *Evansacarus*, *Picicnemidocoptes* and *Micnemidocoptes*.[6] Species within the genus *Knemidocoptes* known as "face mites" invade the stratum corneum and feather follicles of the face and cere, while "scaly leg mites" inhabit the legs and feet;[2] some species occur on both the legs and face.[7] Others occur at the base of feathers and are referred to as "depluming mites."[7]

The entire life cycle of *Knemidocoptes* spp. mites occurs on the host; therefore, transmission is generally direct.[2] Clinical signs vary according to parasite and host species, and may be influenced by immunosuppression and genetic factors.[8] For mites affecting the skin of the legs and face, mechanical trauma from the burrowing activity of the mites, as well as the release of excretory and secretory products, results in hyperkeratosis and dermal inflammation.[9] Grossly, these changes present as thickened skin with scales, crusts and scabs.[5] If severe, there can be loss of digits, feet or limbs.[10] Depluming mites burrow to the feather base and result in feather loss without hyperkeratosis.[11]

When hyperkeratotic growths are present on the face and legs, knemidocoptiasis may be the suspected diagnosis. However, infections may resemble avian pox[10] or papillomatosis,[12] and these should be considered as differential diagnoses. Mites are members of the phylum Arthropoda, and are recognized histologically by their chitinous exoskeleton, striated muscles, a tracheal ring and jointed appendages.[13] Knemidocoptic acariasis (mange) may be diagnosed using deep skin scrapings cleared in 10% KOH to identify morphological features.[9] Molecular techniques are useful for corroboration of species identification and subsequent phylogenetic analysis allows for taxonomic diagnosis.[6]

Knemidocoptic acariasis is commonly reported worldwide in domestic poultry and pet birds.[2] *Knemidocoptes mutans* and *K. gallinae* occur in poultry, while *K. pilae* affects psittacines.[14] *K. jamaicensis* occurs in wild passerines and is not known to infect gallinaceous or psittacine birds.[14] The recommended treatment is ivermectin (0.2 mg/kg, PO, IM or topically) or moxidectin (0.2 mg/kg, PO or topically), repeated in 2 weeks.[14,15] For small birds, intramuscular dosing may be toxic, and oral or topical routes of administration are preferred.[14] In larger birds, topical creams and liquids are generally not as effective as the entire bird needs to be treated.[8]

The topical use of rotenone-orthophenylphenol, crotamiton, and lindane is not recommended due to toxicity concerns.[14]

Far less is known about the occurrence, pathology and significance of knemidocoptiasis in wild birds.[16] Infections have been reported in wild birds[2] in the orders Anseriformes,[14] Charadriiformes,[2] Columbiformes,[2] Falconiformes,[17] Galliformes,[18] Passeriformes,[19] Piciformes,[20] Psittaciformes,[21] and Stringiformes.[22] In recent years, reports of knemidocoptic acariasis in wild birds are increasing.[2,8,11,16,23-32] It is not known if this represents a true increase in occurrence or simply increased reporting and investigation of cases by wildlife health diagnostic laboratories. Factors potentially associated with increased reports include stressors in hosts making them more susceptible to disease, expansion to new hosts or geographic areas, or increased virulence in the parasite.[33]

While infection with *Knemidocoptes* spp. can result in debilitation and mortality in individual birds, the impact on avian populations is not well known.[9] During a *Knemidocoptes* spp. epizootic in a population of evening grosbeak (*Hesperiphona vespertina*) from Flagstaff, Arizona an estimated 25% of the flock had knemidocoptic acariasis affecting the legs and feet.[34] While affected birds had limited walking and perching ability, there were no significant differences in body weight or gonad/body weight ratios between affected and unaffected birds. Likewise, in a study of Eurasian tree sparrows (*Passer montanus*) from Hong Kong, body weights in birds infected with *Knemidocoptes* spp. and uninfected birds were not significantly different.[25] However, in a study of warblers in the Dominican Republic, birds infected with *K. jamaicensis* had reduced muscle mass, lowered site persistence, and did not return following annual migration.[35] During a *K. jamaicensis* epizootic in American robins, affected birds were lethargic with debilitating lesions that likely interfered with feeding and increased susceptibility

to predation.[10] While epizootic knemidocoptiasis is unlikely to have a long-term effect on population size, many factors should be considered in the management of infected populations including host population dynamics, and parasite transmission rates, virulence, and recovery rates.[10] In the current case, the knemidocoptic acariasis is not thought to have contributed to mortality as the pine grosbeak was in good body condition with evidence of active feeding and died from a window strike. While multiple reports of affected pine grosbeaks in the area suggested an epizootic, only a single bird was found dead and examined.

The use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the US government.

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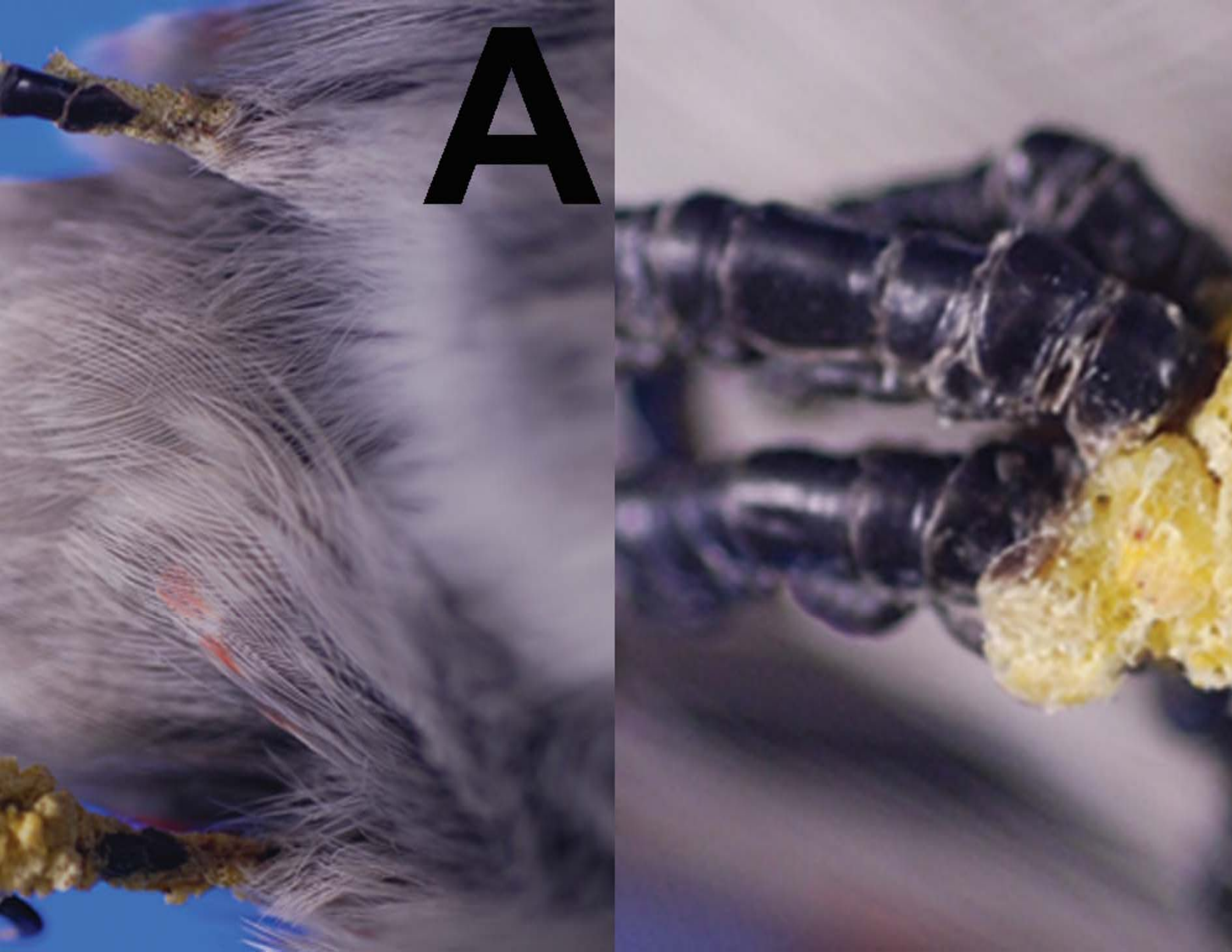
Figure legends

Figure 1 — Photographs of the legs of an adult, male pine grosbeak (*Pinicola enucleator*) that was found dead under a window. A — Yellow, raised, nodular crusts encircle the tarsometatarsi and are present on the cranial and lateral aspects of the tibiotarsi. B — Higher magnification of the left leg showing yellow, raised, nodular crusts on the tarsometatarsus.

Figure 2 — Photomicrographs of a transverse section of the tibiotarsus from Figure 1. A — Within the stratum corneum of the cranial tibiotarsus, there was diffuse severe orthokeratotic hyperkeratosis. Throughout the keratin, there were clear spaces (mite tunnels) (*) that often contained sections of mites (†). Notice the normal caudal skin (‡). Tibiotarsal bones are in the center of the section (§). H&E stain; bar = 1 mm. B — Higher magnification of a mite from the tibiotarsus. Mites were approximately 300 µm in diameter with an eosinophilic exoskeleton with spines (*), a hemocoel (†), striated muscle (‡) and jointed appendages (‖). H&E stain; bar = 50 µm. C — Mite eggs (*) were occasionally observed adjacent to mites found within the stratum corneum of the tibiotarsus. H&E stain; bar = 50 µm. Photomicrographs of mites extracted from the frozen leg of a pine grosbeak (*Pinicola enucleator*). D — Ventral view of female *Knemidocoptes jamaicensis* with larva (*) in situ. Bar = 100 µm. E — Dorsal view of female *Knemidocoptes jamaicensis* with larva (*). Bar = 100 µm.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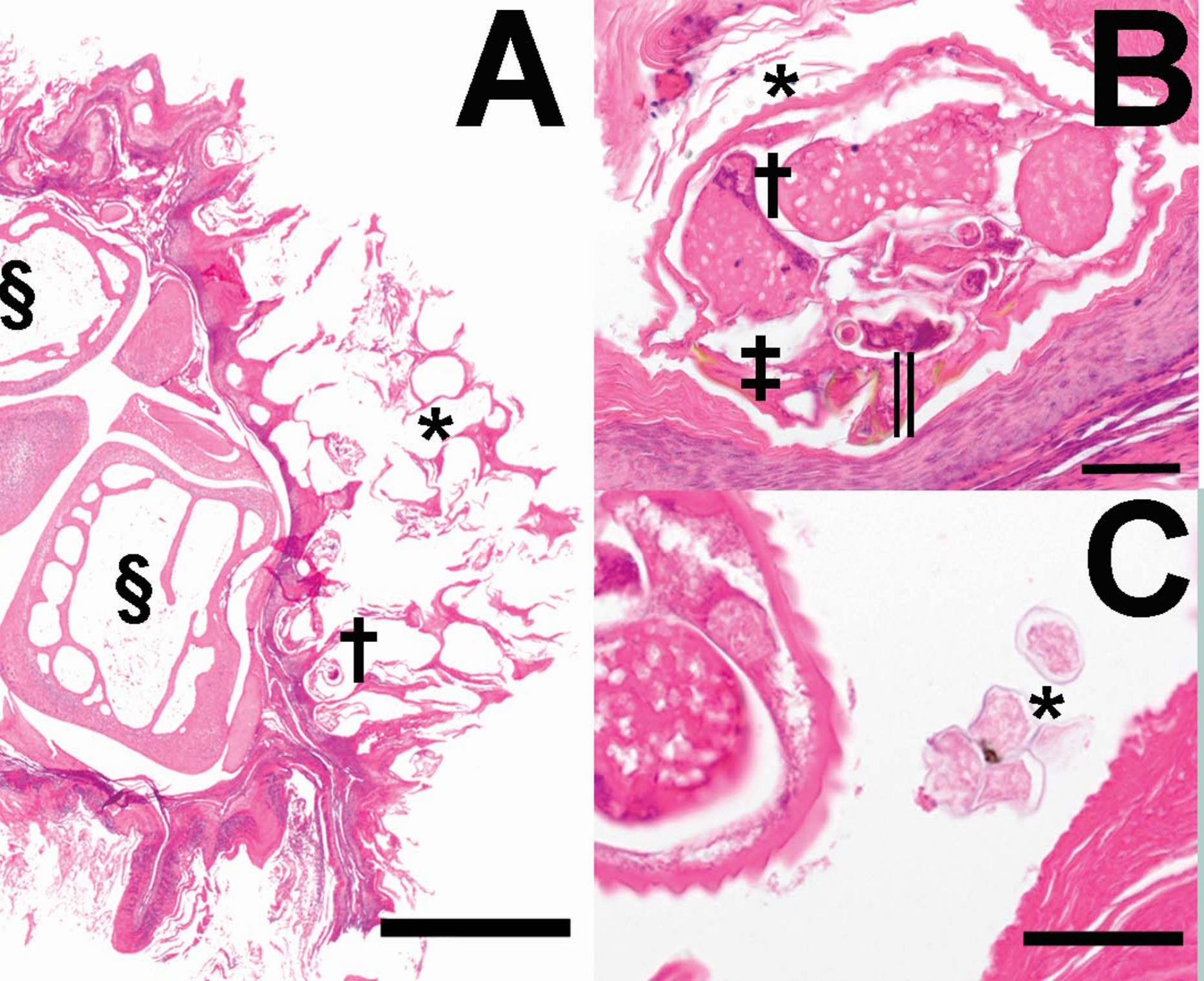
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