



# WEDNESDAY SLIDE CONFERENCE 2025-2026

Conference #25

06 May 2026

## Case I:

**Signalment:** 26 y 9 m, male, *Tiliqua scincoides intermedia*, northern blue-tongued skink



**Figure 1-1. Liver, blue-tongued skink:** Approximately 70% of the liver was expanded and replaced by numerous white, well-demarcated, soft nodules up to 14mm in diameter. (Photo courtesy of Smithsonian's National Zoo and Conservation Biology Institute, Wildlife Health Sciences <https://nationalzoo.si.edu/animals/veterinary-care>)

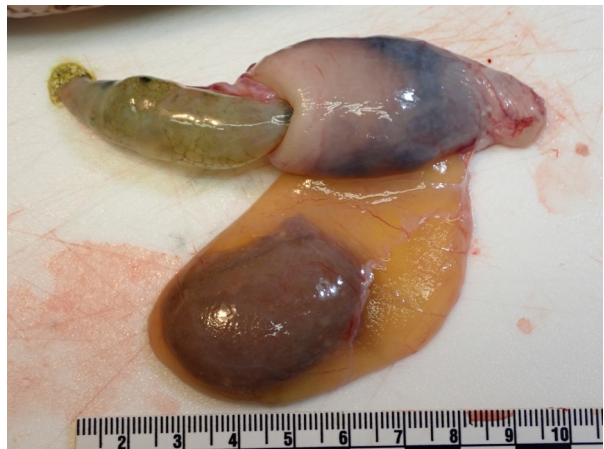
**History:** Physical exam performed due to continued lethargy, complete anorexia, weight loss noted by keeper staff. Physical exam showed a lethargic, weak, pale 6-10% dehydrated blue-tongue skink. No masses noted on coelomic palpation, but significant muscle catabolism noted. Bloodwork showed increasing serum phosphorus, and uric acid indicative of renal disease. Due to quality of life concerns euthanasia performed via IV injection in the tail vein of

Euthasol (pentobarbital/phenytoin solution) and potassium chloride mixed 1:1.

## **Gross Pathology:**

Body condition was reduced with minimal coelomic fat and only remnants of shrunken, orange fat bodies. There was a moderate amount of clear coelomic fluid.

Approximately 70% of the liver was expanded and replaced by numerous white, well-demarcated, soft nodules up to 14 mm in diameter. The spleen was mottled with tan nodules up to 3 mm in diameter. There were white, chalky areas within both kidneys, up to 1.5 cm in diameter expanding



**Figure 1-2. Colon, blue-tongued skink:** Approximately 1.5 cm of the colon telescoped within the distal colon, and the intussusceptum was red, thickened, and not easily reduced, (Photo courtesy of Smithsonian's National Zoo and Conservation Biology Institute, Wildlife Health Sciences <https://nationalzoo.si.edu/animals/veterinary-care>)

and compressing the surrounding tissue. The urinary bladder contained a soft, grey, free-floating urocystolith.

Approximately 1.5 cm of the colon telescoped within the distal colon, and the intussusceptum was reddened, thickened, and not easily reduced.

**Laboratory Results:**

Urocystolith confirmed to be 100% urate crystals in a protein matrix.

**Microscopic Description:**

The slide contains two sections of colon. Expanding the lamina propria and invading and disrupting all layers of the colon wall is an unencapsulated, poorly demarcated, highly cellular neoplasm. The edges of the neoplasm have an exophytic to polypoid growth habit that protrudes into the colonic lumen. Neoplastic cells are arranged in sheets, trabeculae, acini, and nests within a variably dense fibrovascular to myxomatous matrix. Acinar lumina and some nests frequently contain degenerate and non-degenerate heterophils and abundant karyorrhectic debris. Nests often have keratinized inner layers of cells which have sloughed and laminated into keratin pearls. Neoplastic cells are polygonal, ranging from cuboidal to squamous, with distinct cell borders and moderate

amounts of amphophilic cytoplasm. Anisocytosis and anisokaryosis are moderate to marked. Nuclei are oval with vesicular chromatin and 1-2 distinct, magenta nucleoli. Mitotic rate is 5-10 per 40x HPF. Bizarre mitotic figures and occasional multinucleation are noted. Individual cell necrosis and individual cell keratinization are common. Neoplastic cells often surround vasculature and occasional neoplastic cells are noted in vascular lumina.

Multifocally, the tumor is infiltrated by heterophils and lower numbers of lymphocytes and plasma cells. Superficial/luminal portions of the mass are broadly necrotic and overlain by a fibrinohemorrhagic pseudomembrane. Some portions of the luminal surface are keratinized and laminated (slide variability). The pseudomembrane and necrotic portions of the mass are heavily colonized by rod bacteria, and there is occasional mineralization within the necrotic tissue.

Adjacent non-neoplastic mucosa has marked lymphoid hyperplasia within the lamina propria and scattered goblet cell hyperplasia of the epithelium. Lymphatics and veins in the serosa are markedly dilated.

**Contributor Morphologic Diagnosis:**

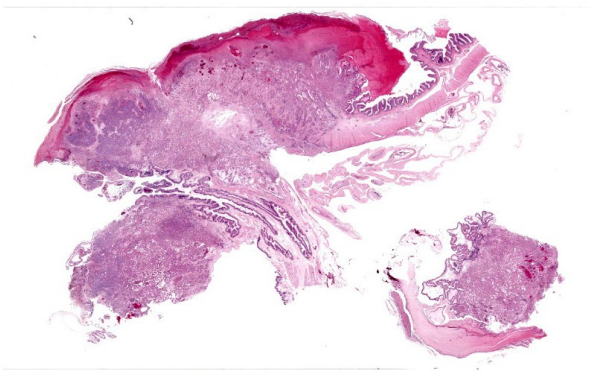
Colon: Colonic adenosquamous carcinoma with ulceration, necrosis, and colonies of rod bacteria.

Colon: Intussusception, chronic (not apparent in slide submitted).

Liver, spleen, lungs, heart, urinary bladder, pancreas, fat bodies (slides not submitted): Metastatic adenocarcinoma.

**Contributor Comment:**

Gastrointestinal adenosquamous carcinomas are rare malignancies in mammals and even less commonly reported in the alimentary tract of reptiles. A tumor is considered adenosquamous if it exhibits significant rep-

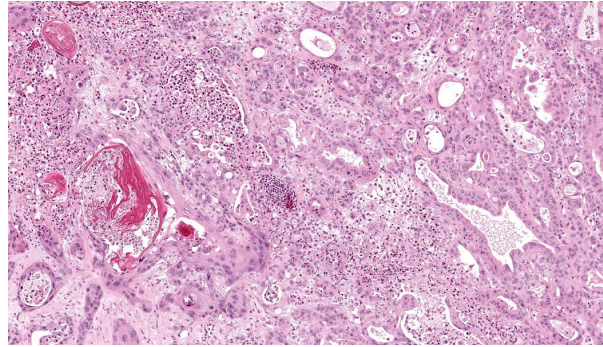


**Figure 1-3. Colon, blue-tongued skink: The colon is transmurally infiltrated by a neoplasm with a segmentally ulcerated surface (HE, 10X).**

resentation of both glandular and squamous differentiation.<sup>5,6,8</sup> Adenosquamous is a descriptor that is most commonly used in respiratory, alimentary, and mammary tumors with mixed glandular and squamous features and is not specific to any one cell of origin. The malignancy in this case clearly demonstrates glandular formations common in colonic adenocarcinomas, but some areas show nesting, keratinization, and even keratin pearl formation characteristic of squamous cell carcinomas. This tumor was highly metastatic – most likely due to hematogenous spread – and established itself in the liver, spleen, lungs, heart, urinary bladder, pancreas, and fat bodies of the animal. Tumor cells at metastatic sites did not maintain squamous differentiation and only occasionally formed vaguely glandular arrangements, with the vast majority of metastases composed of sheets of malignant cells.

Colonic malignancies of any type are uncommon in reptiles. In a 2004 retrospective of 5353 reptile submissions by Garner et al., neoplasia was not uncommon, with a prevalence of 9.8% across all species submitted (527 tumors).<sup>1</sup> Lizards (n= 1909) had a neoplastic prevalence of 8.5%. No cases of colonic adenocarcinoma were reported in any lizard, chelonian, or crocodylian. Only in snakes were cases reported, and in that taxon only 6/325 tumors were diagnosed as colonic adenocarcinomas, indicating these tumors are quite uncommon at ~1.1% of reptile tumors in the retrospective. There was one case of intestinal carcinoma in lizards (0.6% of lizard tumors), but it was small intestine.

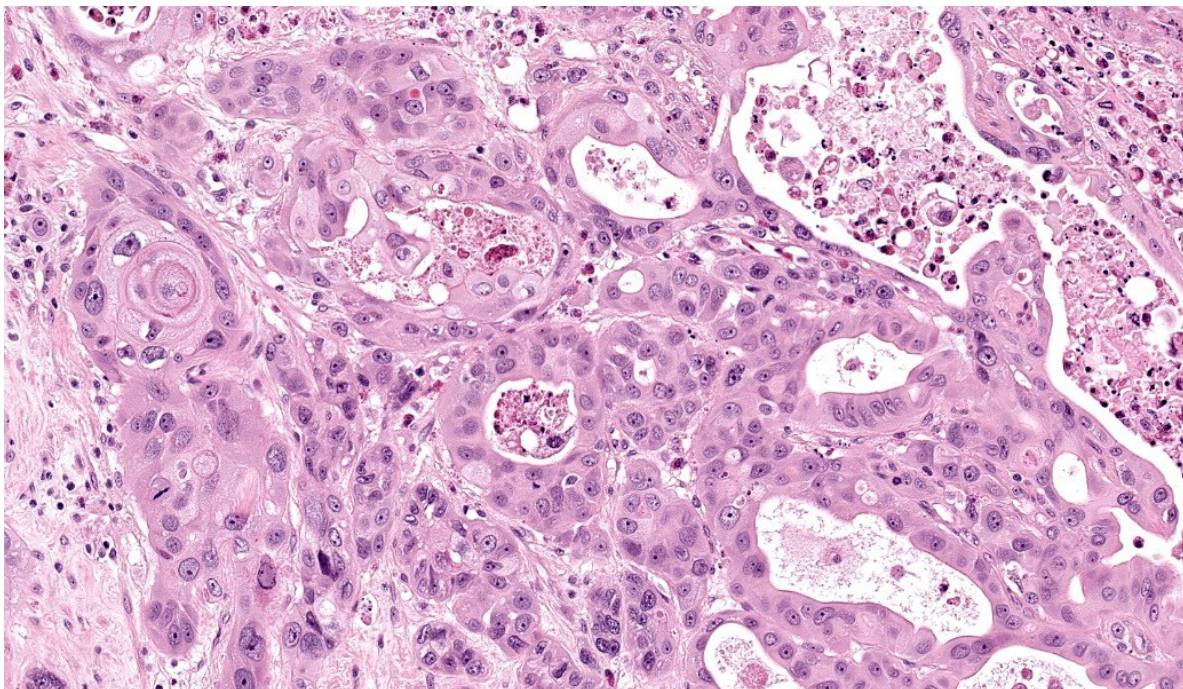
In records from the Smithsonian's National Zoo and Conservation Biology Institute, seven cases of colonic adenocarcinoma were identified in lizards (contributor's unpublished research). Three species were represented: 1 blue-tongued skink (*Tiliqua* spp.,



**Figure 1-4. Colon, blue-tongued skink: The neoplasm is composed of moderately pleomorphic epithelial cells arranged in variably ectatic glands, trabeculae and nests. Some nests contain brightly eosinophilic lamellae of keratin, and acini often contain necrotic debris and sloughed cells. (HE, 160X)**

this case), 4 Gila monsters (*Heloderma* spp), and 2 African plated lizards (*Gerrhosaurus validus*). While these are all heavy-bodied arid-environment lizards, they are not taxonomically closely related, and the overrepresentation should be interpreted in light of their long lifespans and popularity in zoo collections. Interestingly, the cases represent a prominent proportion of adult necropsy findings in these species (1/6 blue-tongued skinks, 2/5 plated lizards, and 4/12 Gila monsters). No cases of colonic adenosquamous carcinoma were described in the National Zoo's records for any species, though an adenosquamous carcinoma was described on the hemipenis of a Mexican lance-headed rattlesnake (*Crotalus polystictus*) and the esophagus of a wood duck (*Aix sponsa*).

Grossly, the section of colon including the tumor had an identifiable intussusception. Intussusception is the telescoping of a section of bowel (the intussusceptum) within an adjacent segment (the intussusciens), generally due to abnormal motility of the bowel smooth muscle. Intussusception is most common in young animals, where it is frequently associated with parasitism or inflam-



**Figure 1-5. Colon, blue-tongued skink: High magnification of pleomorphic neoplastic cells. While most neoplastic cells are arranged in acini, here is central keratinization of nests of epithelium (center left) (HE, 381X).**

mation. In the less frequent adult cases, tumors are often contributory. In humans, a retrospective of adult intestinal intussusception found that over 77% of cases were associated with a tumor, and nearly 60% of the intussusceptions were associated with a malignancy (74% of the tumors).<sup>2</sup> In the case presented here, the adenosquamous carcinoma is presumed to be the inciting cause of the grossly identified intussusception.

**Contributing Institution:**

Smithsonian's National Zoo and Conservation Biology Institute, Wildlife Health Sciences <https://nationalzoo.si.edu/animals/veterinary-care>

**JPC Morphological Diagnosis:**

Colon: Adenosquamous carcinoma

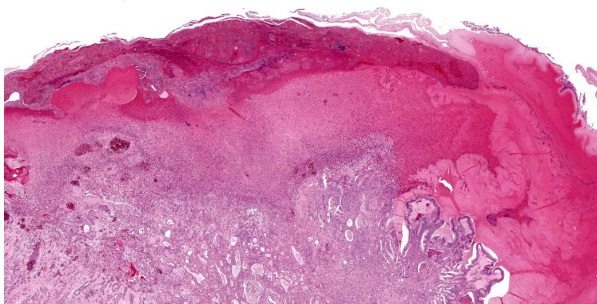
**JPC Comment:**

We crossed the finish line of this year's conferences with the amazing Dr. Kali Holder from the Smithsonian National Zoo! Dr.

Holder brought her signature passion for pathology and exceptional comedic timing, setting the tone for a highly entertaining discussion on this first case. The neoplasm in this skink was diagnosed as an adenosquamous carcinoma, likely arising from the colon, with clear areas of both glandular and squamous differentiation. One participant noted that squamous differentiation in reptiles can also be due to hypovitaminosis A and chronic irritation,<sup>7</sup> postulating whether this could represent an adenocarcinoma with secondary squamous metaplasia rather than a true adenosquamous carcinoma. The organization of the squamous and glandular components convinced most attendees to support the ultimate diagnosis, however. When considering the disseminated metastasis of the primary carcinoma seen in this skink, Dr. Holder boldly exclaimed, "Don't put butt cancer in your heart! That's no way to run a skink!" Indeed.

The gross photographs, which are not provided to participants prior to conference, were crucial to diagnosing the intussusception in this case. Although uncommon in reptiles, intussusception is a well-recognized sequela to intestinal masses in numerous species, as they disrupt the coordinated peristaltic rhythm required to keep the bowel moving in a single direction.<sup>4</sup> Dr. Holder reviewed the pathophysiology of intussusception, which starts when a small fold of bowel telescopes into the adjacent segment, narrowing the lumen and causing partial or complete obstruction.<sup>4</sup> This leads to proximal distension, vascular compromise, edema, congestion, and inflammation. As the process worsens, fibrin accumulates on the serosa of the intussusceptum, which may cause adhesions between the intussusceptum and intussusciens. Severe cases progress to segmental necrosis, or even sloughing of the affected intestine.<sup>4</sup>

The difference between “intussusceptum” and “intussusciens” is a common sticking point for residents. A good way to differentiate between the two is making a mental connection between the word “recipient” and “intussusciens”, which is the “recipient” of the intussusceptum. “Recipient” is basically part of the word “intussusciens!”



**Figure 1-6. Colon, blue-tongued skink: The surface of the neoplasm is necrotic and covered with a serocellular crust. (HE, 29X).**

In this skink, the neoplasm likely initiated a cascade of necrosis, inflammation, and mechanical disruption, culminating in the intussusception. This combination would likely have caused anorexia which, in reptiles, rapidly leads to dehydration.<sup>2</sup> Dehydration, in turn, causes renal stress and the precipitation of urate crystal deposition (gout).<sup>2</sup> Increased uric acid and urolithiasis were reported in this animal. This combination of unpleasantness likely contributed to this animal’s clinical decline.

Dr. Holder closed this case with a discussion on how intestinal carcinomas in reptiles may be more common than currently recognized as improvements in husbandry, veterinary care, and pathology understanding allow more reptiles to reach ages where neoplasia becomes more prevalent.<sup>1</sup> Among reptiles, intestinal carcinomas are most common in snakes, less common in lizards, and rare in chelonians.<sup>1</sup>

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## **CASE II:**

### **Signalment:**

Juvenile female striped skunk (*Mephitis mephitis*)

### **History:**

none

### **Gross Pathology:**

The skunk was in good body condition with normal fat stores, and in good post

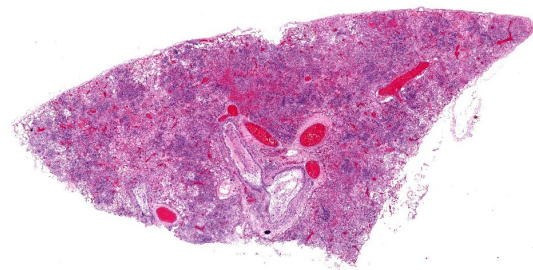
-mortem condition. There were small numbers of fleas in the fur. There was a small amount of cloudy pink nasal discharge bilaterally. The cranioventral lung lobes were bilaterally dark red, wet, heavy, and firm. The right cranial lung lobe was mildly enlarged. All lung lobes contained small numbers of slender white worms up to 2cm in length. There were 16 ascarids in the gastrointestinal tract, 10 of which were in the stomach.

### **Laboratory Results:**

Aerobic culture of the lung yielded a heavy growth of a *Pseudomonas* bacteria. Another colony type grew as well, but could not be separated from the heavy *Pseudomonas* growth.

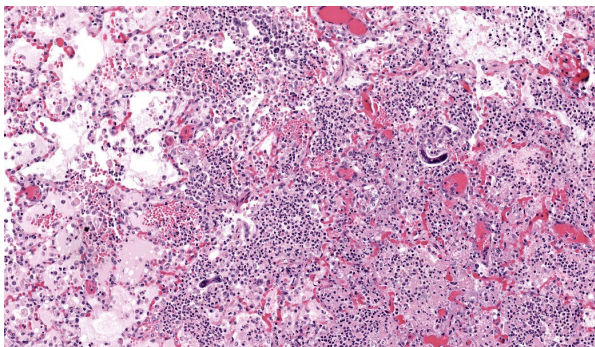
### **Microscopic Description:**

Pulmonary architecture is diffusely mildly to severely distorted by necrosis and inflammatory infiltrates. Bronchiolar submucosa is markedly expanded by dense infiltrates of neutrophils and macrophages, which often infiltrate surrounding alveoli. Diffusely, alveolar septa



**Figure 2-1. Lung, skunk:** The submitted section of lung is diffusely consolidated with areas of parenchymal hypercellularity. (HE, 10X).

are undergoing fibrinoid necrosis, and protein-rich edema, sometimes with fibrin strands, fills alveoli. The walls of small arteries are infiltrated by neutrophils and macrophages and segments are undergoing fibrinoid necrosis. There are mild to severe hemorrhages scattered throughout the lung. There are large numbers of slender rod-type bacteria throughout most of the examined section, occasionally forming dense colonies that line vessels, alveolar walls, or bronchial and bronchiolar epithelium. There are smaller numbers of coccoid bacteria arranged in doublets or clusters, with small colonies generally found in close proximity to each other. Where bronchial and bronchiolar epithelium is present, there are moderate numbers of eosinophilic intracytoplasmic and rarely intranuclear inclusion bodies ranging from 2-6µm diameter. Segmental bronchi are surrounded by marked interstitial edema, and there is mild to marked pleural edema and hemorrhage. Some sections have moderate numbers of larval nematodes which are 12-20µm in diameter and up to 100µm long, and lack a body cavity. These parasites have a slender serrated cuticle 1-2µm thick and lateral alae. They are rarely abutted by multinucleated giant cells, and



**Figure 2-2. Lung, skunk: Areas of hypercellularity correspond to alveoli filled with neutrophils, eosinophilic, macrophages, and cross and tangential sections of metastrongyle larvae. There is multifocal septal necrosis. (HE, 290X).**

there are occasional elongate hyperchromatic basophilic structures suggestive of degenerating nematodes.

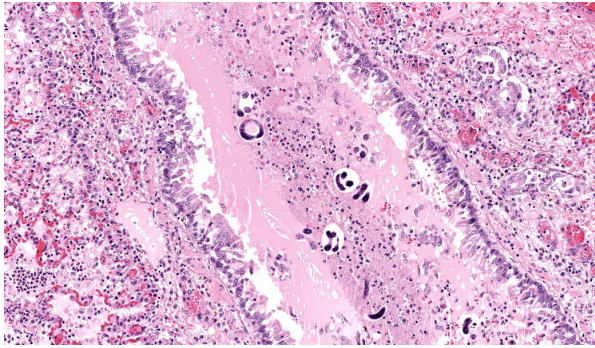
### **Contributor's Morphologic Diagnosis:**

Lung: Pneumonia, bronchointerstitial, necrotizing, acute, diffuse, severe, with growth of multiple bacterial species, and eosinophilic intracytoplasmic and intranuclear viral inclusions in epithelia, etiology consistent with canine *distemper virus*; and regional pulmonary larval nematodiasis

### **Contributor's Comment:**

Canine distemper virus (CDV) is an enveloped, negative sense, single-stranded RNA virus in the family Paramyxoviridae, genus Morbillivirus.<sup>3</sup> The virus causes disease in both wild and domestic canids, as well as many other carnivores including seals, raccoons, weasels and the domestic ferret, skunks, and large cats such as lions and leopards; occasional outbreaks in populations of endangered large cats can have devastating population-level effect.<sup>1,5,7,8,11,18</sup> Dogs and raccoons are the most common reservoir populations. Other closely related viruses include phocine distemper virus and the morbilliviruses that cause disease in cetaceans, measles virus, Hendra virus that infects horses and humans, and peste des petits ruminants viruses.<sup>3</sup> Rinderpest, another morbillivirus that causes severe to fatal disease in cattle, was eradicated in 2011 with the help of vaccines.<sup>20</sup>

Initial replication of CDV occurs in tissue macrophages. The virus then spreads to tonsils and bronchial lymph nodes, spleen, lymphoid follicles in the lamina propria of the stomach and small intestines, other lymph nodes, and Kupffer cells; fever and leukopenia ensue. The virus is spread hematoge-



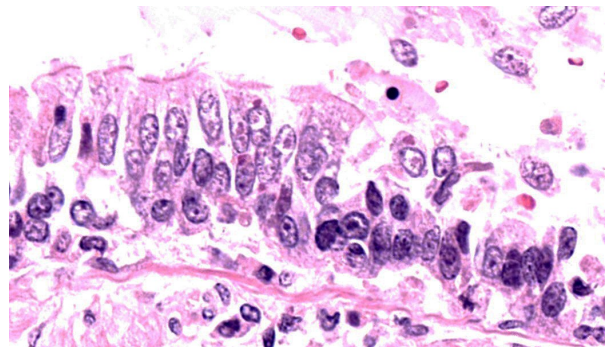
**Figure 2-3. Lung, skunk: Airways contain refluxed alveolar contents. The airway epithelium is hyperplastic with individual epithelial cell necrosis. (HE, 281X).**

nously to epithelia and to the central nervous system; once the virus begins replicating in epithelia, shedding ensues. Virus is most abundant in respiratory secretions and is commonly spread by droplets, but it can also be isolated from urine, and can be spread transplacentally. Shedding ceases once the immune system controls the virus, but can persist in some animals up to 90 days. Approximately 25-75% of dogs infected with CDV will have a strong humoral and cell-mediated immune response. Their signs may be entirely subclinical or limited to a brief fever, and the virus is cleared within two weeks of infection. Where dogs fail to develop a strong immune response, initial clinical signs are conjunctivitis and fever, followed by vomiting and diarrhea, anorexia, cough, increased respiratory effort, and secondary infections.<sup>3</sup> Some patients may then resolve the CDV infection, while others develop neurologic signs, which are almost always progressive. Neurologic signs include ataxia, tremors, myoclonus, seizures, coma, and death.<sup>2</sup>

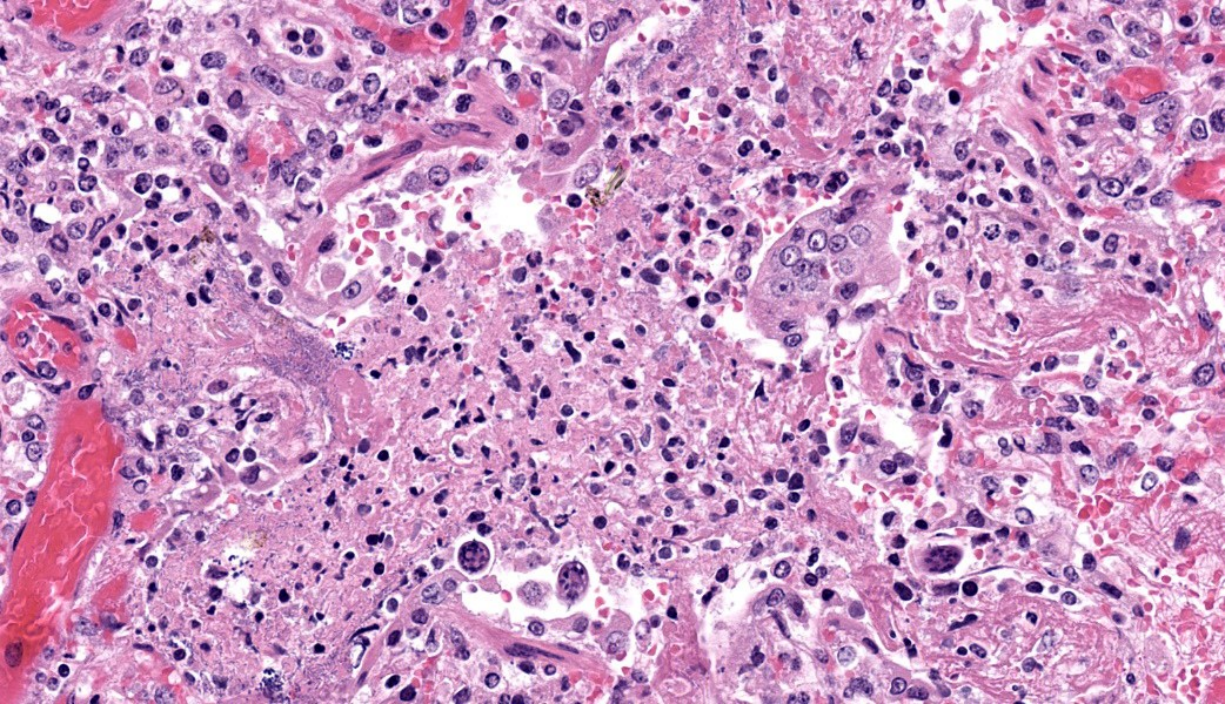
Canine distemper virulence is associated with immunosuppression and neurotropism. Viral H protein binds to CD150 (signaling lymphocyte activation molecule), which is found on dendritic cells and activated mono-

cytes, as well as both B- and T-cells. Early infection in monocytes and dendritic cells may interfere with normal antigen presentation, and upregulation of CD150 in infected animals may further enhance spread of the virus amongst lymphocytes.<sup>14,17</sup> CD4 (+) lymphocytes are first infected and lysed<sup>6</sup>, and viral depletion combined with lack of cytokine stimuli from CD4 (+) cells combine to markedly reduce B-cells as well. Severe immunosuppression predisposes infected animals to secondary viral and bacterial infections, as with the bacterial pneumonia seen in this skunk.<sup>2</sup>

One to three weeks after recovery from systemic illness, some dogs develop neurologic disease. Virus is spread both anterograde up the axon and via circulating lymphocytes. Once in the brain, replication in the ependymal and choroid plexus epithelium allows virus to circulate in the CSF.<sup>16</sup> Acute encephalitis is a result of direct viral replication and injury in the central nervous system, with minimal inflammation. Virus is first detected in astrocyte foot processes and then neurons, and occasionally neuronal necrosis can lead to foci of polioencephalomalacia.<sup>13</sup> Historically, CDV infection has been thought of as a demyelinating disease. Though oligodendrocytes are seldom infected, infection of surrounding astrocytes and



**Figure 2-4. Lung, skunk: Airway epithelium contains both internuclear and intracytoplasmic viral inclusion. (HE, 1792X).**



**Figure 2-5. Lung, skunk: Within alveolar spaces there are bacterial colonies (left), multinucleated viral syncytia with intracytoplasmic viral inclusions (center right), and cross sections of larval ascarids with lateral alae. (HE, 701X)**

microglia are thought to lead to oligodendrocyte dysfunction. However, other studies have demonstrated axonopathy prior to demyelination.<sup>12</sup> Whether axonopathy is due primarily to neuronal infection or to bystander damage from infected astrocytes and microglia is uncertain. In patients that survive distemper virus infection, with or without associated neural signs, a replication-deficient form of the virus may persist in the brain and can re-emerge years later to cause neural signs in a condition termed “Old Dog Encephalitis”.<sup>3</sup>

Suspicion for canine distemper virus infection is based on noting clinical signs in a susceptible animal. Antemortem testing includes serologic assays and PCR, and observation of distemper inclusions in circulating erythrocytes. Common findings on histology of tissues collected post-mortem are atrophy of lymph nodes, splenic white pulp, and

other lymphoid organs; and during the systemic phase of disease, secondary bacterial infection may be present in the lungs and gastrointestinal tract. Lesions in the brain are usually leukoencephalomalacia with marked spongiosis. Mononuclear infiltrate is variable; there may be digestion chambers and large numbers of gitter cells. Characteristic eosinophilic cytoplasmic viral inclusions can be found in lungs, brain, adrenal gland, gastric mucosa, and urinary bladder to varying degrees in any infected carnivore.<sup>4</sup> Nuclear inclusions are more common in neurons. If inclusions are not obvious, immunohistochemistry for the virus is elucidative.<sup>3</sup>

At necropsy, this skunk had severe cranioventral pneumonia. Lung submitted for aerobic culture grew a *Pseudomonas*; this bacterium may have inhibited growth of other organisms seen histologically. Bacterial infection was secondary to severe canine distemper virus infection. Inclusions are readi-

ly apparent in the lung, but were confirmed with immunohistochemistry. The skunk tested negative for rabies on DFA, and distemper inclusions were absent from the brain: as the skunk was still in the systemic phase of disease, intracranial infection may have been yet to be established. Regional infection of the lung by larval nematodes was an incidental finding; these may be *Filaroides milksi* or *Crenosoma mephitidis*.

### **Contributing Institution:**

University of Connecticut Department of Pathobiology and Veterinary Science  
<http://www.patho.uconn.edu/>

### **JPC Morphologic Diagnosis:**

Lung: Pneumonia, bronchointerstitial, necrotizing and neutrophilic, subacute, diffuse, marked, with bronchiolar epithelial hyperplasia, viral syncytia, intraepithelial and intrahistiocytic intracytoplasmic and intranuclear viral inclusions, larval nematodes, and mixed bacteria.

### **JPC Comment:**

What an excellent write-up by this contributor! Dr. Holder set the stage for this case with a quick skunk taxonomy review. Their scientific name, *Mephitis mephitis*, basically translates to “stinky stinky.” As if that wasn’t enough, their family name, Mephitidae, also means “stinky.” Taxonomists really wanted to make sure no one missed the point there. With that poignantly olfactory context established, discussion advanced.

The lung sections showcased classic morbillivirus pathology, including syncytia in both epithelial cells and macrophages. However, because this skunk also had a secondary bacterial pneumonia, participants found themselves squinting at multinucleated cells won-

dering, “Is this a viral syncytial cell or just an enthusiastic giant cell macrophage?” Dr. Holder pointed out that using viral inclusions when visible within multinucleated cells can help tip the pathologist one way or the other, but she encouraged participants to accept that, without IHCs, not every multinucleated Joe on a slide is going to confess to its villain origin story.

One of the most interesting features in this case was the prominence of pulmonary megakaryocytes, which appear as large, basophilic, “ink blot” cells lounging around in the septal capillaries like they own the place. One participant pointed out that the lungs have their own megakaryocytes separate from those in the bone marrow and are a major site of platelet production in many mammalian species. Pulmonary megakaryocytes have important immune functions, as well. In humans, pulmonary megakaryocytes can become significantly more noticeable in severe disease states, and, in SARS-CoV-2 infections, they’re considered a poor prognostic indicator.<sup>15</sup>

Regarding the bacterial infection that set up shop after morbillivirus did its damage and immunosuppressed this skunk, there were two distinct bacterial morphologies within areas of necrotic airways. Because tissue preservation was good in this case, these organisms were interpreted as true pathogens rather than postmortem freeloaders.

The group briefly discussed the nematodes present in the lung. Some larvae had lateral alae, prompting speculation *about Baylisascaris columnaris*, but the overall appearance favored metastrongyles as discussed by the contributor. Dr. Holder summed it up with characteristic flair by proclaiming, “A wild animal without parasites is a stadium with-

out fans.”

Dr. Holder shared that she is convinced if we ever get a zombie apocalypse, it’s going to be due to a morbillivirus. She wrapped up this case discussion with morbillivirus immunopathology, including lymphotropism, immunosuppression, and “immune amnesia.” Morbilliviruses target lymphocytes via CD150 (SLAM). When a dendritic cell gets infected and traffics to regional lymph nodes, it can transmit virus to memory T cells, which are subsequently destroyed. Memory B cells are also depleted, and morbilliviruses can wipe out up to 70% of preexisting immune memory cells.<sup>10</sup> The result is a long-lasting vulnerability to other infections and reduced vaccine effectiveness.<sup>10</sup>  
Bummer

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### **Case III:**

#### **Signalment:**

Adult, female, Atlantic stingray, *Hypanus sabinus*

#### **History:**

This aquarium-housed Atlantic stingray ini-

tially presented to veterinary staff for a single, nodular mass on the ventral aspect of the left pectoral fin. Within one week, a second mass was noted. Excisional biopsy was elected and, at the time of surgery, multiple raised, hyperpigmented masses were found along the ventral surfaces of both pectoral fins. White purulent material was expressed from an excised nodule. Aerobic bacterial culture of the material yielded *Aeromonas* and *Staphylococcus spp*; however, no infectious agents were identified on cytology or histology. The animal was euthanized 13 months later due to a non-healing wound on the ventral pectoral girdle and progression of the nodular skin lesions along the pectoral fins.

#### **Gross Pathology:**

At necropsy, there were numerous (>50) firm-to-hard, well-demarcated, pale tan nodules on the ventral aspects of the pectoral and anal fins, ranging from 1-10 mm in diameter. On cut section, the nodules exuded thick, pale tan fluid. Other gross findings included a roughly 3 cm diameter cutaneous ulcer on the ventral the pectoral girdle, transudative coelomic effusion (15 ml), and multiple, 1-3 mm, firm, light tan nodules within the gill arches and along the ventral aspect of the spinal column. The liver was diffusely dark brown in color and sections sank in formalin (consistent with depleted hepatic lipid stores).

#### **Laboratory Results:**

Cytology: Unstained smears of fluid collected from the skin nodules showed numerous, variably-sized, round, birefringent crystals. No infectious organisms were identified on Diff-Quik stained slides.

#### **Microscopic Description:**



**Figure 3-1. Pectoral fin, Atlantic stingray:** There are numerous hard, well-demarcated, pale tan nodules on the ventral aspects of the pectoral and anal fins, ranging from 1-10 mm in diameter. (Photo courtesy of: Johns Hopkins University, School of Medicine Department of Molecular and Comparative Pathobiology, <http://mcp.bs.jhmi.edu/>)

Two, full-thickness sections of pectoral fin including skin, skeletal muscle, and radial cartilage: Markedly expanding the hypodermis are multiple, variably-sized (up to 7mm diameter) nodules comprising aggregates of amorphous to finely granular, lightly to darkly-basophilic mineralized material surrounded by fibroblasts and narrow zones of dense, fibrous collagen. Both the mineralized deposits and surrounding fibrous tissue are infiltrated by variable numbers of inflammatory cells including macrophages, lymphocytes, and eosinophilic granulocytes. Occasionally, larger nodules extend into and disrupt underlying skeletal muscle and radial cartilage. There is also multifocal mineralization of the radial cartilage without associated inflammation or deformation. In the epidermis overlying the nodules there is moderate intra- and extracellular edema. Multifocal separation and loss of the epidermis may be artefactual given the lack of associated hemorrhage and inflammation.

**Contributor Morphologic Diagnosis:**

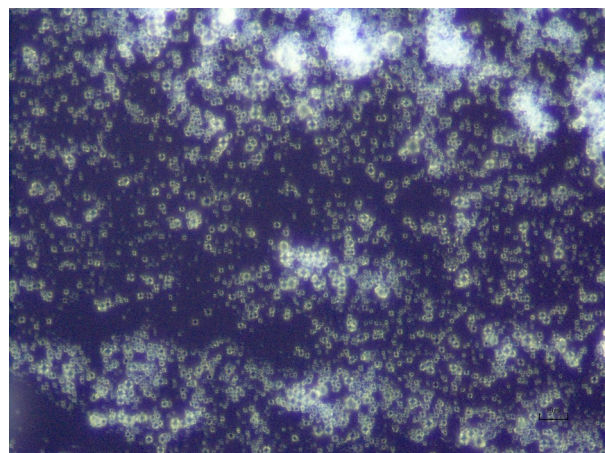
Skin and skeletal muscle (pectoral fin): mineralization, chronic, multifocal to coalescing, severe with fibrosis, lymphohistiocytic and

granulocytic inflammation

**Contributor Comment:**

Gross, cytologic, and histopathologic findings in this Atlantic stingray were consistent with widespread soft tissue mineralization. In addition to the skin, nodular foci of mineralization with associated chronic inflammation and fibrosis were found within connective tissue of the gill arches and surrounding to the vertebrae. Mild, multifocal mineralization was also evident in the kidneys, liver, and choroid plexus.

Soft tissue mineralization has been reported in multiple elasmobranch species including cownose rays, a bowmouth ray, a coral catshark, and a swell shark.<sup>3,8</sup> The diagnostic veterinary pathology service at Johns Hopkins has identified similar, but less severe, lesions in two other Atlantic stingrays from the same collection. Clinically, rays often present with firm, tan skin nodules lesions along the pectoral fins, tail, dorsal midline, and ventrum.<sup>8</sup> The condition is progressive and can affect multiple internal organs in-



**Figure 3-2. Pectoral fin, Atlantic stingray:** Unstained smears of fluid collected from the skin nodules demonstrate numerous, variably sized, round, birefringent crystals. (Photo courtesy of: Johns Hopkins University, School of Medicine Department of Molecular and Comparative Pathobiology, <http://mcp.bs.jhmi.edu/>)



**Figure 3-3. Pectoral fin, Atlantic stingray: Expanding the hypodermis, there are numerous areas of coalescing foci of mineralization. (HE, 10X)**

cluding heart, vessels, kidneys, smooth muscle of the gills, intestines, and reproductive organs. Clinical signs include weight loss and death, likely as a result of the changes in the gills and cardiovascular system.

The pathogenesis of soft tissue mineralization in elasmobranchs is poorly understood. Gross and histomorphologic features of the nodular skin lesions closely resemble calcinosis circumscripta, which, in mammals, most commonly occurs over bony prominences and is thought to represent dystrophic mineralization related to previous trauma.<sup>5</sup> However, involvement of internal organs in elasmobranchs is more suggestive of metastatic mineralization secondary to calcium/phosphorus imbalance. Inappropriate calcium supplementation, either in the water or diet, and underlying renal disease have been suggested as potential contributors.<sup>8</sup> In the present case, there were histologic changes indicative of chronic kidney disease including tubular atrophy and loss, glomerulosclerosis, and interstitial fibrosis.

Though skeletal anatomy and function vary greatly among elasmobranch species, the

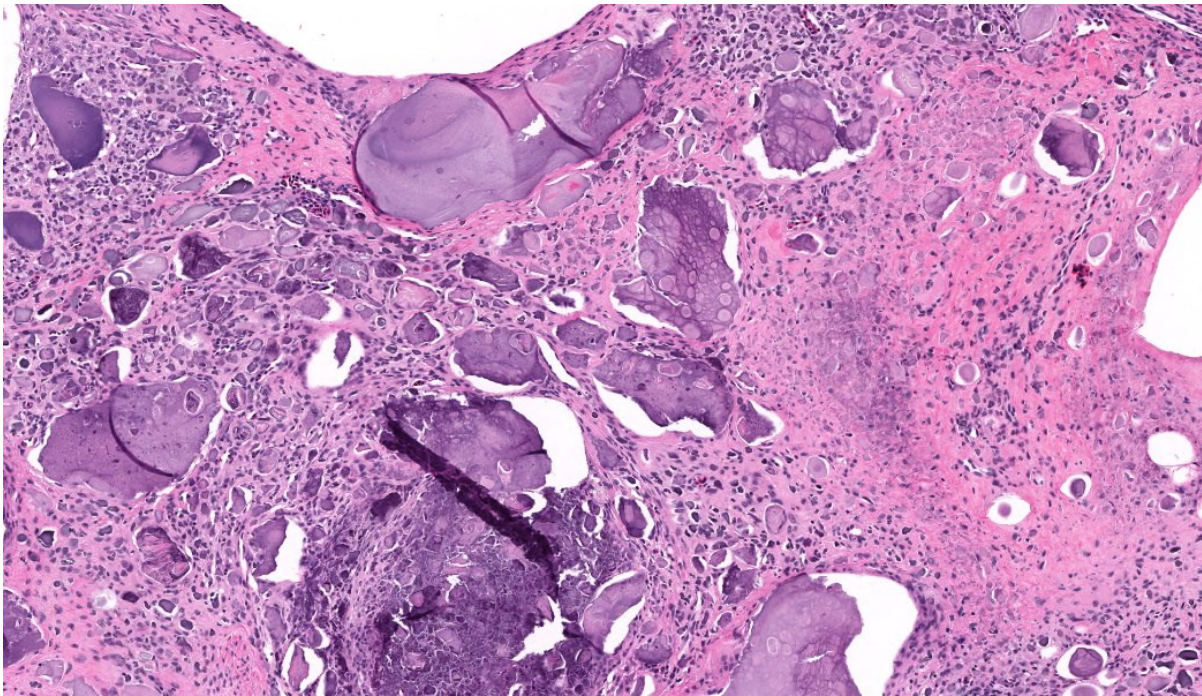
endoskeleton generally consists of chondrocytes within an uncalcified extracellular matrix, surrounded by a fibrous perichondrium. Within the axial and appendicular skeleton, mineralized units (called “tesserae”) form between the cartilage center and the outer perichondrium.<sup>1,2</sup> In this stingray, the areas of mineralization within the cartilaginous radials of the pectoral fin (without associated deformation or inflammation) may be a variation of expected mineralization for the species.

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#### **JPC Morphologic Diagnosis:**

Fin, hypodermis and joint space: Mineralization, chronic, multifocal to coalescing,



**Figure 3-4. Pectoral fin, Atlantic stingray: Foci of mineral are admixed and surrounded with moderate numbers of macrophages, and fewer granulocytes and lymphocytes on a dense fibrous stroma. (HE, 151X)**

marked, with granulomatous inflammation.

**JPC Comment:**

This case took participants into the world of elasmobranch pathology. Dr. Holder emphasized that the primary process in this lesion was mineralization; not dermatitis, inflammation, or infection - just good, old-fashioned calcium being in places where calcium should not be.

Participants noted mineral deposition not only in the soft tissues, but also within joint spaces. Rays normally possess mineralized skeletal elements called tesserae, which may extend to articular surfaces, but the intra-articular mineral in this case was prominent enough to catch the eyes of participants. However, as mentioned by the contributor, this could be a normal variant. The literature lacks information on what degenerative tesserae look like because elasmobranch skele-

tal remodeling is essentially thought to be nonexistent - just tesserae... forever.

The discussion then shifted to the relevance of the stingray's liver, which was grossly described as dark brown and sank in formalin. Elasmobranchs rely on hepatic lipid stores for buoyancy and a healthy liver should float.<sup>7</sup> A sinking liver indicates profound negative energy balance, and underscores how sick this ray was.

Tumoral calcinosis is a well-recognized but poorly understood condition in elasmobranchs. Two major forms occur - hydroxyapatite deposition disease (HADD) and calcium pyrophosphate deposition disease (CPDD).<sup>4</sup> HADD is extremely common in reptiles, so much so that this is almost exclusively the form they get. HADD in reptiles is often accompanied by urate deposition. Crystals are granular, rounded, and have



**Figure 3-5. Pectoral fin, Atlantic stingray: There is mineralization of the cartilage of the fin as well. (HE, 151X)**

minimal, soft birefringence, as in this case.<sup>4</sup> HADD is also associated with osteoarthritis in humans.<sup>4</sup> CPDD, on the other hand, is most common in mammals and birds. Crystals are rhomboid to spicular with bright blue to yellow birefringence.

As a final fun fact, Dr. Holder noted that elasmobranchs can be aged (by people who have this skill) by counting the layers of tesserae in their vertebrae.<sup>5</sup> This sounds like a sort of elasmobranch tree ring system, but sharks have the audacity to do it in cartilage instead of wood.

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#### Case IV:

##### Signalment:

27 y.o female Philippine crocodile (*Crocodylis mindorensis*)

##### History:

Adult female Philippine crocodile presented with blepharospasm and palpebral edema of left eye. Physical exam with ultrasound revealed retrobulbar mass of soft tissue. Fine needle aspirate cytology report revealed mesenchymal cells assessed as potentially neoplastic. A prolonged course of meloxicam and long-acting antibiotic was initiated, but eye did not improve. Two weeks later, CT revealed mass invading posterior chamber at the eye as well as widespread pulmonary consolidation and fibrosis. Repeated ocular ultrasound confirmed invasion of posterior chamber. Later enucleation of eye with as much retrobulbar tissue as possible was

performed, and bulb and adnexa were submitted to pathology as a biopsy. The animal was found dead the morning after enucleation and was submitted to pathology for necropsy.

### Gross Pathology:

The dorsomedial aspect of the globe is expanded by a rounded tan soft tissue mass that rises approximately 3 mm from the scleral surface and infiltrates through the fibrous tunic of the eye. Upon sectioning the eye, the entire posterior chamber is occupied by a multinodular tan soft tissue mass with multifocal hemorrhage. The mass anteriorly displaces the lens, and the anterior chamber is partially collapsed.

Philippine crocodile, left globe, bisected. The posterior chamber is filled by a multilobular white mass with multifocal hemorrhage.

### Laboratory Results:

Fungal 18S rRNA PCR sequencing identified *Purpureocillium lilacinum* in tracheal wash samples from this animal

### Microscopic Description:

Left eye. Disrupting the fibrocartilaginous tunic of the eye, infiltrating and obliterating the choroid, anteriorly displacing the retina, and filling >80% of the posterior chamber is a multilobular mass of coalescing granulomas, necrotic and cellular debris, and hemorrhage. Granulomas are characterized by central cores of densely eosinophilic protein, necrotic debris, degranulated heterophils, and negative-staining hyphal filaments. These cores are surrounded by abundant multinucleated giant cells and epithelioid to foamy macrophages, many with large, clear vacuoles. Individual lobules are separated by variable amounts of fibrous tissue infiltrated by lymphocytes, plasma cells, and intact het-

erophils.

Fungal hyphae are nonpigmented, 2-4 um in diameter, parallel-walled, and septate, with dichotomous branching. Portions of the retina are adhered to the posterior surface of the ciliary body. The remaining retina is fragmented, vacuolated, and infiltrated by heterophils. Granulomas focally extend into anteriorly displace the ciliary body. The remaining vitreous humor is multifocally coagulated and contains heterophils, detached retinal pigmented epithelium and erythrocytes. The anterior surface of the lens capsule is multifocally adhered by fibrin to pigmented epithelial cells consistent with those on the posterior surface of the iris and ciliary body, which also display accumulations of fibrin (posterior synechiae). The iris is anteriorly displaced, the iridocorneal angle is collapsed, and the anterior chamber is reduced. The iris is infiltrated by low numbers of lymphocytes, macrophages and heterophils. The cornea has reduced stromal separation artifact (corneal edema).

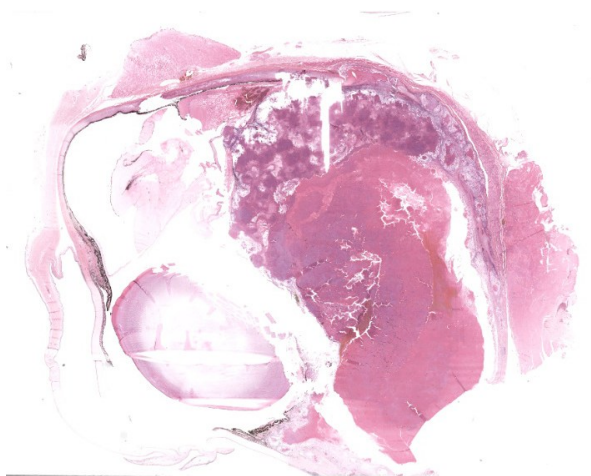


Figure 4-1. Eye, crocodile. The posterior uvea, from the caudal aspect of the ciliary body to the choroid is lined by numerous coalescing heterophilic granulomas and an heterophilic exudate fills the posterior chamber is filled with abundant brightly eosinophilic cellular debris. (HE, 9X).

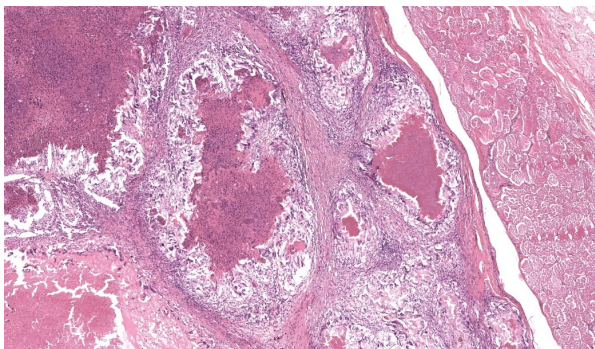
**Contributor's Morphologic Diagnosis:**

Left eye (OS): Panophthalmitis, granulomatous and heterophilic, severe, with abundant nonpigmented fungal hyphae.

**Contributor's Comment:**

The origin of the intra-ocular mycosis is presumed dissemination of fungi from a granulomatous pneumonia, which was found on necropsy the day following this enucleation. The pulmonary granulomas contained abundant morphologically identical fungal hyphae and widespread *Pseudomonas aeruginosa* colonies. Tracheal exudate cultured a fungus that was identified via 18S rRNA PCR as *Purpureocillium lilacinum* (formerly *Paecilomyces lilacinus*).

The ocular lesions in this case are not particular to a specific fungal organism. Indeed, ocular dissemination is a well-reported manifestation of systemic aspergillosis in German shepherd dogs. Anatomically, the retina of crocodilians is largely avascular, relying almost entirely on the richly vascular choroid layer just below.<sup>7</sup> The expansile granulomas visible in this case clearly show that they originated in this vascular layer, dis-

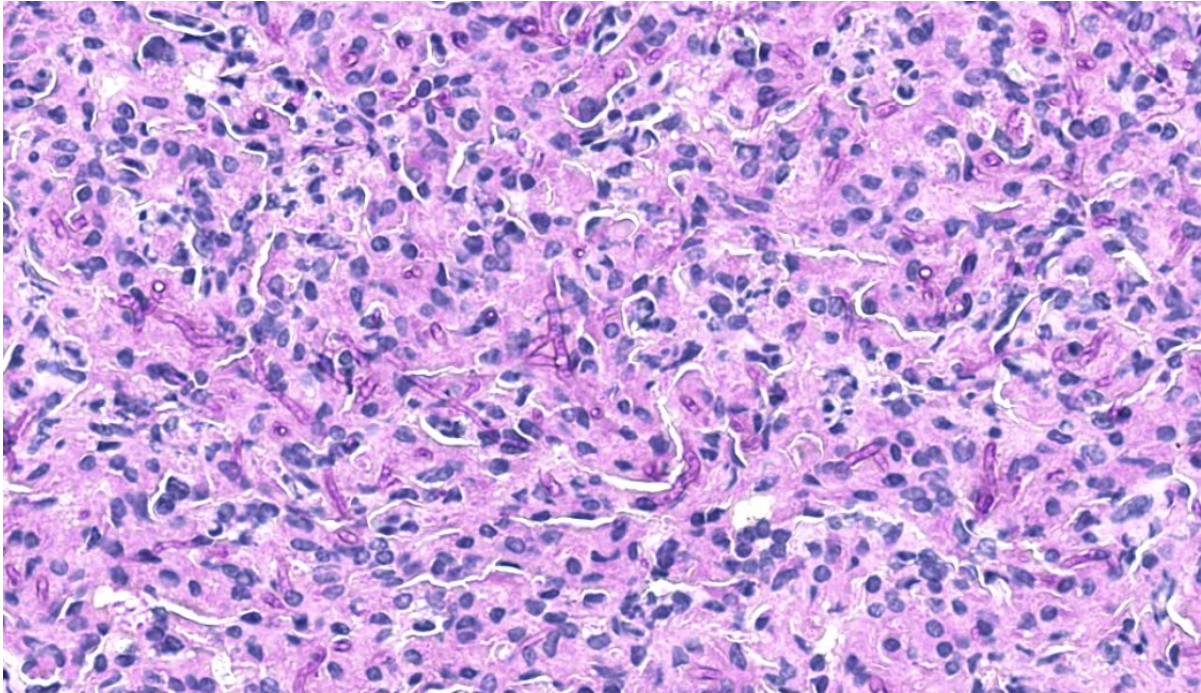


**Figure 4-2. Eye, crocodile: Heterophilic granulomas contain a central area of degenerate heterophils surrounded by a layer of epithelioid and foreign body-type macrophages, in turn surrounded by concentric lamellae of fibrous connective tissue containing lymphocytes and plasma cells. (HE, 83X).**

placing the retina anteriorly and deforming and infiltrating the sclera.

Hematogenous spread of fungal pathogens is a potential complication of any angioinvasive fungal infection, and in domestic animal veterinary medicine *Aspergillus*, *Fusarium*, and the Mucorales are often implicated.<sup>7</sup> In addition to saprophytic fungi such as *Aspergillus*, in reptiles, systemic mycoses are often caused by entomopathogenic fungi, such as *Purpureocillium* or *Metarhizium*.<sup>3,9</sup> *P. lilacinum* is well reported as a cause of fatal systemic mycoses in turtles, crocodilians, and snakes.<sup>3,6,8,9</sup> Rapidly-growing opportunists such as *P. lilacinum* are a particular danger to reptiles under high stocking density, cold stress, or unsanitary environmental conditions.<sup>8</sup> In this case, *P. aeruginosa*, a bacterium fully capable of acting as a primary pathogen in an immunocompetent host, may have initiated the pneumonia and *P. lilacinum* was a secondary invader that subsequently seeded the eye. It is also plausible that there was an undetected stressor that resulted in *P. lilacinum* pneumonia with a secondary *Pseudomonas* co-infection.

This fungus is not solely a reptile pathogen. *P. lilacinum* has also been reported as a cause of fungal keratitis in humans, and general or local immunosuppression was a risk factor.<sup>2</sup> A recent paper from Louisiana identified 21 fungal pneumonia cases in wild Virginia opossums, a subset of which were successfully identified via fungal isolation and/or PCR as *P. lilacinum*.<sup>5</sup> The genus *Purpureocillium* has recently been found to contain another species, *P. lavendulum*, closely related to *P. lilacinum*, which has been reported in fibrinous pneumonias of a green tree python and a panther chameleon.<sup>10</sup> *Javendulum* replicates more readily below 35°C than *P. macinum* and is thus of poten-



**Figure 4-3. Eye, crocodile: Granulomas extend around to the posterior aspect of the degenerating ciliary body. (HE, 83X)**

tial importance as a reptile pathogen though of less concern for mammals or birds.

**Contributing Institution:**

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<https://nationalzoo.si.edu/animals/veterinary-care>

**JPC Morphologic Diagnosis:**

Globe: Panophthalmitis, heterophilic and granulomatous, chronic, diffuse, severe, with anterior and posterior synechiae, retinal detachment and degeneration, anterior lens luxation, and numerous fungal hyphae.

**JPC Comment:**

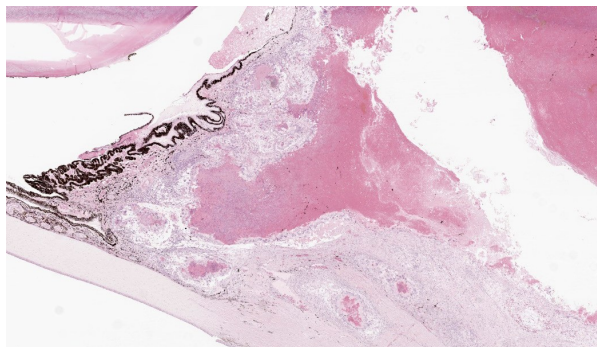
Dr. Holder opened the final case of the year by ranking crocodylians on the “Holder Scale of Spiciness.” The Philippine crocodile, she

explained, is “low spicy per unit mass”, which translates to a contextually polite, manageable reptile compared to, say, the saltwater crocodile, which is “high spicy.” The Cuban crocodile, however, she described as “the ultimate spicy.” With longer legs set more underneath the body, Cuban crocs can gallop and (kind of) jump, and they do so with a raging bad attitude. With that energy established, the group turned to the eye.

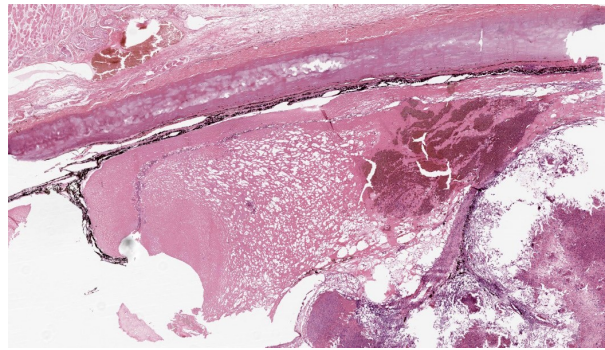
One of the first questions raised during the discussion of this case was the increased cellularity of the lens. Participants wondered whether this represented a degenerative change; however, reptiles and birds possess an annular pad, which is a more densely cellular structure which supports visual accommodation.<sup>4</sup> It is not a degenerative change like one might see in other species, but rather is normal and a direct result of reptile evolution.

The cornea also caused some double takes. The eye had what appeared to be a “double cornea”, but participants astutely presumed that the outer “cornea” was the nictitating membrane, which crocodilians use as both protection and as built-in “swim goggles.”<sup>4</sup> This structure allows them to see underwater without risking their corneal integrity or visual acuity.<sup>4</sup>

Participants also noted lymphoid follicles in the conjunctiva. These were initially mistaken by some as small foci of lymphoplasmacytic inflammation, but crocodilians have normal conjunctival lymphoid tissue.<sup>4</sup> These follicles were a bit hyperplastic, however, in response to the raging fungal panophthalmitis. On H&E, the fungal hyphae stained negatively, appearing as faint, ghostly outlines that Dr. Holder described as “haunting the slide.” A PAS stain brought them out into the light. This led to a broader discussion about fungal diagnostics and how temperature can profoundly affect fungal morphology.<sup>9</sup> For this reason, fungi may have different appearances in tissue between mammals and reptiles. And a reminder to all - appearance alone on histology should not be considered definitive for speciation<sup>9</sup> - accurate identification requires molecular testing, supported by morphology, for any fun-



**Figure 4-4. Eye, crocodile: Granulomas extend around to the posterior aspect of the degenerating ciliary body. (HE, 83X)**



**Figure 4-5. Eye, crocodile: The drainage angle is filled with hemorrhage and fibrin. (HE, 48X)**

gus.

The culprit in this case, *Purpureocillium lilacinum*, is a saprophytic fungus that thrives in humid environments where meat is used as a food source. Basically, crocodile enclosures are its dream home. Fat from food creates a film on the water, which deposits on the floor of the tank and serves as an organic substrate for the fungus to grow.<sup>7</sup> *Purpureocillium lilacinum* gets its name from the formation of purple to rosy fungal mats, both in culture and in tissue, making it one of few fungi with built-in aesthetics.<sup>1</sup> Dr. Holder noted that *Purpureocillium spp* are also associated with pneumonia in opossums, whose lower body temperature makes them “step-reptiles” in terms of fungal susceptibility.<sup>5</sup> She also emphasized that stocking density plays a major role in *Purpureocillium* outbreaks, and crowded enclosures create ideal conditions for fungal spread.<sup>10</sup>

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