Viruses, Bacteria, and Fungi, Oh My! Common Infectious Diseases of Reptiles

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In the past two decades, there has been a rise in the number of emerging and re-emerging infectious diseases reported in reptiles. Emerging infectious diseases include newly identified pathogens, while those characterized as re-emerging include those that may have been previously characterized but are being reported with increased frequency. Veterinarians play an important role in the diagnosis of infectious diseases in herpetological collections and should closely monitor the literature to keep abreast of new findings and current research.

The rise in emerging infectious diseases in reptiles may be attributed to several factors, including the increased number of reptiles being imported into the United States, poor quarantine and sanitation programs, and improved diagnostic assays. The popularity of reptiles in the United States remains high, with millions of reptiles being imported annually. The popularity of reptiles has led to the growth of reptile swap meets, where herpetoculturists have the opportunity to select from a large number of different reptile species. At these swap meets, large numbers of reptiles are maintained in relatively small areas with minimal/no biosecurity. Herpetoculturists routinely handle different specimens without washing their hands, possibly introducing and disseminating pathogens through the reptiles. The sanitation methods used to control or eliminate pathogens in reptile collections may also be suspect. Inappropriate use of disinfectants may lead to the development of resistant strains of microbes.

The number of diagnostic tests available to the clinician treating reptiles has increased dramatically over the past ten years. Historically, clinicians treated all “infections” in reptiles as bacterial diseases. However, over the past two decades, there have been an increased number of reports of viruses and fungi being isolated from diseased reptiles. The advent of molecular diagnostic testing has led to the development of highly sensitive and specific enzyme-linked immunosorbent assays, polymerase chain reaction (PCR), and reverse-transcriptase PCR.

The incidence of herpesvirus infections in chelonians has been on the rise since originally being isolated from sea turtles in 1975. Herpesvirus infections have been identified in freshwater, marine, and terrestrial species of chelonians. Transmission of the herpesvirus is believed to be primarily via the horizontal route, although it has been suggested that a vertical route of transmission is also possible. Affected animals may present with rhinitis, conjunctivitis, necrotizing stomatitis, enteritis, pneumonia, and neurological disease. Molecular diagnostics, electron microscopy, and viral isolation have been used to diagnose herpes infections in chelonians. Affected animals should be provided appropriate supportive care (e.g., fluids, enterals, and antibiotics) to control clinical signs. Acyclovir has been used with some success by reducing viral replication. However, there is no effective treatment for this virus. Affected animals should not be released into the wild to prevent translocation of the virus to naïve chelonians.

Ranavirus is an emerging disease of chelonians. This virus has a high morbidity and mortality. It has been isolated from both captive and wild chelonians. Affected animals typically develop upper respiratory signs (e.g., palpebral edema, conjunctivitis), lower respiratory signs, oral ulcers, cervical edema, and gastrointestinal signs. Diagnosis can be done using PCR. There is currently no effective treatment for affected animals.

Bearded dragon atadenovirus was first reported in Australia in the early 1980's. The virus was not characterized in the United States until more than a decade later. Since that time, the virus has spread through the bearded dragon population in the USA and should be considered endemic. Transmission of the virus is primarily by the direct route (fecal-oral), although vertical transmission may also be possible. Affected animals may present with anorexia, weight loss, limb paresis, diarrhea and opisthotonous. Concurrent dependovirus and coccidial infections have also been observed in neonatal bearded dragons. Biopsies of the liver, stomach, esophagus, and kidney may be collected to confirm diagnosis (ante-mortem). On histopathology, basophilic intranuclear inclusion bodies are strongly suggestive of adenoviral infection. A PCR assay can be used to detect adenovirus in the feces of affected animals. There is no effective treatment for adenoviral infections, although supportive care (e.g., fluids, enterals, and antibiotics) may be useful in stemming the secondary effects of the disease. Again, very little is known regarding the epidemiology of this virus; therefore, special precautions should be taken when working with affected animals.

Mycoplasmosis is a bacterial infection that has been associated with severe disease in chelonians. Affected animals may present with nasal and ocular discharge, conjunctivitis, palpebral edema and pneumonia. Mycoplasmosis has also been identified in squamates and crocodilians. There are several diagnostic tests available to confirm mycoplasmosis in reptiles, including culture, an ELISA and a PCR assay. Microbiologic culture can be used to confirm an infection, but it is difficult to isolate this bacteria and time consuming. Currently, parallel testing using both the ELISA and PCR assays provides the highest degree of sensitivity. Treatment may be attempted using tetracyclines and flouroquinolones. Mycoplasmosis has been associated with declines in native tortoise populations in the United States and treatment of wild specimens is not recommended.

Cryptosporidium serpentis is considered a "plague" of captive snake collections. This apicomplexan parasite has been associated with both high morbidity and mortality in captive collections. Affected snakes commonly regurgitate their meals, have a mid-body swelling, and are dehydrated. A variety of methods may be used to diagnose cryptosporidiosis in snakes. Acid-fast cytology of a regurgitated meal or fecal sample is often diagnostic. Because there is currently no effective treatment, affected animals should be culled. *Cryptosporidium saurophilum* is a more recently diagnosed species associated with lizards. Whereas *C. serpentis* is associated with the stomach, *C. saurophilum* is associated with the intestine. Currently, no consistent treatment is available for *C. saurophilum* or *C. serpentis.*

Coccidiosis is a major cause of morbidity and mortality in reptiles. A species of special concern, *Isospora amphiboluri*, is found in bearded dragons. These endoparasites are

especially problematic in neonatal dragons, often resulting in stunting, diarrhea, and death. Whereas most coccidial infections in higher vertebrates are self-limiting, these infections often persist in bearded dragon colonies. Historically, eliminating coccidia from bearded dragons was difficult because most of the therapeutics used to eliminate the parasites were coccidiostatic. Ponazuril (30 mg/kg per os once with a second treatment 48 hours later) is coccidiocidal and has excellent therapeutic value against *I. amphiboluri*. Quarantine and environmental disinfection/sanitation should also be done to eliminate coccidia from dragon colonies.

Microsporidians are obligate intracellular parasites that are actually primitive fungi. The life cycle of these parasites includes both merogenic and sporogenic phases. These parasites are common in lower vertebrates (e.g., fish), but have also been implicated as a concern in humans with acquired immunodeficiency virus. Bearded dragons infected with these parasites can present with a similar clinical picture as adenovirus or coccidiosis. Affected dragons are anorectic, unthrifty, cachectic, and may die acutely. Diagnosis is generally made at post-mortem. Hepatic and renal necrosis is common, although other organ systems (e.g., intestine and gonads) may also be affected. There is no effective treatment. To limit the likelihood of introducing this parasite into a collection, herpetoculturists should only acquire animals from reputable breeders and quarantine any new arrivals for a minimum of 60-90 days.

Infectious diseases will continue to be important differentials for cases presented to veterinarians. It is important for veterinarians working with these species to consider the complete history and biosecurity associated with individual pets and collections when ascertaining the potential role of infectious diseases in a case. Ultimately, we have much to learn about the epidemiology of these cases, but if we all continue to collect and share data from our cases we can start to develop strategies to better manage infectious diseases in reptiles.