RESPIRATORY INFECTIONS IN CHELONIA
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Introduction
Respiratory diseases are among the most commonly seen clinical problems in chelonians, especially upper respiratory tract disease (URTD). Lower respiratory tract diseases and combinations of both are also seen. URTD often involves rhinitis, conjunctivitis, stomatitis, and glossitis. Clinical signs can range from anorexia and general lethargy to ocular lesions and/or edema, nasal discharge, and dyspnea. The underlying causes are often multifactorial, and husbandry will often play a role as well as a wide range of infectious agents. The most common agents found in association with respiratory disease in terrestrial tortoises are *Mycoplasma* spp., which can cause URTD. Differentials include herpes or ranavirus infections. In certain species, picornaviruses or intranuclear coccidia should also be considered. Facultative pathogenic bacteria and fungi can also play a role in disease development.

Mycoplasma
Mycoplasma infections are very common in captive chelonians. A variety of *Mycoplasma* spp. have been described in these animals. They are known to be an important cause of URTD in terrestrial tortoises and have also been detected in aquatic turtles, although their clinical importance in those animals is not as well understood. Several distinct mycoplasma species have been described in tortoises. The clinically most important of these is *M. aggasizii* and closely related strains. These are also most often detected in tortoises in Europe. Clinical signs seen in chelonians with mycoplasma infections range from clinically inapparent infections to severe respiratory disease with nasal discharge, dyspnea, lethargy, and death. Clinical signs can also occur intermittently and can be provoked e.g. by stress. Infected animals remain carriers and mycoplasma are shed through the nose and mouth, especially in animals with clinical signs of disease.

Herpesviruses
Herpesviruses are among the most important viruses found in chelonians, and a number of genetically distinct herpesviruses have been found in various turtle and tortoise species. They are most often described in terrestrial tortoises, where they are typically associated with diphtheroid-necrotizing stomatitis, but can also cause rhinitis, dyspnea, and conjunctivitis, as well as hepatitis and meningoencephalitis. Four distinct herpesviruses have been described in tortoises so far, testudinid herpesvirus (TeHV)1 mostly in Russian tortoises (*Testudo horsfieldii*), TeHV2 in gopher tortoises (*Gopherus* spp.), TeHV3 in various Mediterranean tortoises (*Testudo* spp.), and TeHV4 in African tortoise species. TeHV1 and 3 are the most common types seen in tortoises in Europe. Herpesvirus detection in
aquatic turtles has increased in recent years, and several have been described in conjunction with upper digestive tract and upper respiratory tract disease, while others have been detected in individuals that appeared to be clinically healthy.

**Ranaviruses**

Ranaviruses are best known as pathogens of amphibians, but can also infect reptiles and fish. In reptiles, they have most often been described in chelonians, where they can cause similar clinical signs to those seen in herpesvirus infected tortoises, including stomatitis, conjunctivitis, as well as hepatitis and vasculitis. Ranaviruses are not species specific and viruses are capable of switching hosts between a wide variety of ectothermic animals.

**Picornaviruses**

Picornaviruses in the genus *Torchivirus*, also known as virus “x”, have been repeatedly found in captive tortoises in Europe. In juvenile tortoises, they have been associated with severe softening of the carapax and death. In older tortoises, they have been repeatedly detected in conjunction with mycoplasma and/or herpesvirus infections. Infected animals have had wide variety of clinical signs ranging from clinically inapparent carriers to nasal discharge, stomatitis, conjunctivitis, enteritis, and ascites. Cases of sudden death with no clinical signs noted beforehand have also been reported. These viruses are most often detected in spur-thighed tortoises (*T. graeca*), but have also been found in other species.

**Intranuclear coccidia of tortoises (TINC)**

Intranuclear coccidia are found in a variety of tortoise species in association with severe systemic disease and unspecific clinical signs such as lethargy and anorexia as well as in tortoises with chronic rhinosinusitis. TINC is most often found in tropical tortoises (esp. radiated tortoises, *Astrochelys radiata*). Although it has most often been reported in tortoises in North America, it is also found in captive tortoises in Europe.

**Mixed infections**

Mycoplasma infections are often found in chelonians with virus infections, especially herpes or picornavirus infections. What role each pathogen plays in susceptibility and development of disease is not yet understood. It has been hypothesized that mycoplasma may affect the immune systems of infected animals, making them more susceptible to other infectious agents. Additional bacterial or fungal infections with facultative pathogens are common, and can lead to more severe disease.

**Diagnosis**

PCRs are available for the detection of each of the specific pathogens listed above. Oral swabs and nasal washes are the two most common and most important samples for testing in animals with URTD. In the case of chelonians with ranavirus infections, whole blood should also be tested. In animals with
suspected TINC infection, cloacal swabs should also be included. In general, direct pathogen detection should be used for animals with clinical signs, rather than serology, and animals with clinical signs of disease are also more likely to shed pathogens, making it more likely that these will be detected in swabs or washes. The diversity of the normal bacterial flora in the oral cavity of chelonians, consisting mostly of gram negative bacteria, makes evaluation of bacterial testing of oral swabs or nasal washes very difficult.

**Treatment**

Mycoplasma infections should be treated locally and systemically. Nasal washes with physiological saline solution or diluted antibiotics (e.g. enrofloxacin) have been reported to help against clinical disease. Systemic use of e.g. fluoroquinolones, macrolides (clarithromycin), or tetracycline have also been reported. These do not result in freedom from infection, but do help relieve clinical signs and reduce shedding of the pathogen. Infections with TINC can be treated with toltrazuril. The success of the treatment depends on an early initiation and long duration of treatment. Treatment of herpesvirus infections with acyclovir or related substances has been reported, animals that recover remain life-long carriers. Since husbandry can play a role in the development of respiratory disease in chelonians, the husbandry, especially hygiene and environmental temperature should be optimized and supportive therapy initiated for diseased animals. Affected animals should be barrier nursed to avoid infection of contact animals. Secondary infections can play an important role in development and severity of disease, antibacterial and/or antifungal treatment may therefore be necessary.