
THE AMPHIBIAN EYE

Norin Chai, DVM, MSc, MScVet, PhD, DECZM (Zoo Mammals)

Ménagerie du Jardin des Plantes, Muséum national d'Histoire naturelle, 57 rue Cuvier 75005 Paris, France

ABSTRACT: In this presentation the normal anatomy and methods of examination of the amphibian eye are discussed. Then the author reports his own clinical experience in amphibian ophthalmology with the description of several ocular disorders. A short literature on this topic is also given.

KEY WORDS: amphibians, ophthalmology, corneal lipidosis

INTRODUCTION

A thorough examination of the amphibian eye is an important component of health assessment.

ANATOMY

Like other vertebrates, amphibians have a camera eye: presence of an anterior chamber and a posterior chamber. Adaptations seen are quite different among species: from degenerate (caecilians, subterranean urodels) to well developed eyes (anurans, salamanders). Anurans and salamanders represent the majority in zoological collections and have the most developed eyes among amphibians. Thus, this communication will be mainly on this taxonomic group.

Eyes are quite large in terrestrial species, especially in anurans where the vision plays a critical role in the nutritional behavior and predator avoidance. The eyes bulge out so far in frogs that they can see in nearly all-different directions, helpful for an animal that can't turn its head. Prey movement triggers the feeding response. Anurans in particular are voracious feeders and tend to eat anything that fits their mouth. However, frogs don't seem to be concerned with visual detail. Gastric overload and impaction, as well as ingestion of non-food items, such substrate gravel or moss are fairly common. Yet, they will starve to death surrounded by food if it is not moving!

Salamanders show well-developed movable lids. In anurans the lids are not movable. The upper one is immobile. The lower one is a translucent conjunctival membrane that slides over the cornea passively when the contraction of the retractor bulbi muscle pulls the eye into the orbit. A quiescent frog will close its eyelids synchronously every 0 to 5 minutes. They will also blink with eye irritation, whole body vibration, sudden bright light, large approaching dark objects, and prey swallowing. Frogs blink when they eat. They can't chew foods effectively or use their tongue to push food. So retraction of eyeballs is a useful aid in swallowing food. Ocular

movements, other than retraction and its reversal, are negligible. Frog eyes may exhibit a rhythmic motion due to heartbeat or large movement of the lungs.

In some terrestrials species lacrimal function is provided by the Harderian gland (medially located), the lacrimal gland, and the superior eyelid glands. A nasolacrimal duct is not always present. Aqueous drainage occurs through the iridocorneal angle into two ciliary venous sinuses, one dorsal and one ventral. There is no interorbital septum between the two mainly spherical orbital cavities. The sclera of most adult anurans contains hyaline cartilage. Some have a ring of bones. Urodels do not have cartilage in their sclera. The cornea has typical vertebrate characteristics. The pupil has various shapes depending on the species: round, vertical slit, complex shape. Pupillary muscles are striated. Mild contraction of the pupil occurs with light stimulation caused by autonomous activity. Accommodation is achieved by protractor lentis muscles that pull the lens forward. The retina is vascularized and has three cell layers. There is no tapetum and there is limited color discrimination.

OPHTHALMIC EXAMINATION

Because an amphibian's health is very closely dependent on their environmental conditions, husbandry records are very important for the clinician. Even faced with an ophthalmic lesion, reviewing information on both apparently healthy and sick individuals is part of the diagnostic process. Physical examination should be conducted to prevent inaccurate diagnoses and should include evaluation of locomotion, responsiveness to stimulation and a novel environmental factors, behavior, respiratory rate, body condition, and hydration status. Because of the close proximity of the eyes to the pharynx, the oral cavity should be inspected for abnormalities. A thorough periocular examination of the amphibian eye may show palpebral lesions or a deformation of the orbital region. The practitioner should always evaluate ocular symmetry, position and the size of the eyeballs as well as color of the eyes and size of pupils (anisocoria). Neuro-ophthalmologic tests are not conclusive because of the voluntary control of the striated pupillary muscle. Magnification and a good light source are extremely helpful for a close examination. A light source is essential to find the 3 Purkinje-Sanson images and to evaluate the lens. Funduscopic examinations are possible in anesthetized animals. Diagnostic tests include fluorescein staining of the cornea, corneal sampling (scraping, biopsy) for cytology, culture and sensitivity testing.

OCULAR DISORDERS

Trauma may induce superficial ulcerative lesions. The lower eyelid may be sutured to provide protection. Butylcyanoacrylate tissue adhesive has been useful for preserving corneal integrity with deeper corneal erosions.

Dehydration may result in adherence of the eyelids to the cornea. Treatment involves correcting the dehydration, addressing the cause, and gentle manual manipulation to release the eyelids followed by an application of an ocular gel.

“Red leg syndrome” in amphibians, a term referring to hyperemia of the ventral skin of the thighs and abdomen of septicemic anurans, is now synonymous with any generalized bacterial infection in amphibians. It is more properly referred to as bacterial dermosepticemia. Historically this syndrome is associated with *Aeromonas hydrophila*. However, many other infectious agents produce similar integumentary signs. In general, bacterial infections are commonly reported in amphibians under stress. Common causes of stress include transport, suboptimal husbandry, overcrowding, contaminated environments, and parasitism. External ocular disease (blepharitis, conjunctivitis, dacryocystitis, uveitis) might also be seen with such infections. In all cases, culture and sensitivity should be employed to determine the most suitable antibacterial agent. Medicated baths are a common and effective treatment modality which can also be used for hydration. Although much more stressful, injectable antibiotics provide the advantage of allowing administration of an exact dose. Duration of all antibiotic therapy should be at least 7 days.

Ocular diseases can also be associated with viral diseases. We had one case of high mortality in a colony of *Phyllomedusa bicolor*. Three animals presented with keratitis, with or without corneal ulceration. Bacterial infection was confirmed on only one animal. Blood smears revealed inclusion bodies in the erythrocytes. We hypothesized this was of viral disease origin, possibly Iridovirus.

Frog virus 3 (FV3) has been reported to induce ocular malformation in an American bullfrog (*Rana catesbeiana*). The right eye was approximately 50% the size of the left. Stereo and light microscopic examination revealed two granulomas within the orbit. Electron microscopic examination revealed virus particles scattered throughout one structure but mostly aggregated toward the center. Frog virus 3 was confirmed by PCR sequencing.

Parasitic infections of the eye have been described. Trematodes have been found in the eye of adult anurans. Recently, Rhabditid nematodes were associated with ophthalmitis and meningoencephalomyelitis in captive Asian horned frogs (*Megophrys montana*). Gross and histologic findings with intralésional nematodes include varying degrees of ulcerative keratitis, histiocytic uveitis and retinitis, meningoencephalomyelitis, and epidermal chromatophore (iridophore) hyperplasia. One frog was diagnosed with rhabditid nematodiasis antemortem. Clinical signs and lesions in the frog did not progress after unilateral enucleation and anthelmintic treatment were completed.

In amphibians, corneal lesions are the best described. Lipid keratopathy (corneal lipidosis) has been the focus of several publications. Initial signs are corneal opacities that spread to cover 100% of the cornea. Typically, the disease progresses as the infiltrate becomes more thickened, resulting in a raised and irregular surface on the cornea. The underlying cause of this disorder is not clearly known. It is likely that a diet high in cholesterol plays a role. There are other stromal corneal opacities for which no cause has been found. We can use fluorescein to confirm the presence of an ulcer and we can use an extra light to observe the white foci containing cholesterol or lipids. Most amphibians die within 18–24 months of diagnosis, although some frogs survived well over 48 months. Since vision plays an important role in the life of the frogs,

blindness may become an ethical and quality of life issue. Furthermore, based on human reports of corneal xanthomas, the disease is painful. Euthanasia should be discussed at the time of diagnosis.

This discussion has highlighted the fact that there are numerous areas in which further research is required to understand the etiology and pathogenesis of ocular disorders and to better treat and prevent these diseases.

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