

## **Selected Topics in Reptile Clinical Pathology**

Drury Reavill, DVM, Diplomate ABVP, Avian Practice  
Avian Medical Center of Sacramento and California Avian Laboratory  
6114 Greenback Lane  
Citrus Heights, CA 95621  
(916) 969-8855

Lecture given at the U. C. Davis Avian/Exotic Animal Symposium  
1994

### **Selected Topics in Reptile Clinical Pathology**

The class Reptilia encompasses a large and diversified group of vertebrates. Presently, approximately 6,000 species have been identified. The representatives fall into the chelonian, crocodylian, squamate (lizards and snakes), and the Rhynchocephalia (the tuatara) categories.

Identifying the causes of disease in this class of animals presents a challenge for the veterinary practitioner. While several excellent references (see Suggested Reading) can be used as guides, the relevant scientific literature is far from exhaustive on specific conditions in the unusual reptile patient. The astute practitioner needs to use all available diagnostic skills to manage these cases. The use of clinical pathology greatly enhances this endeavor.

Hematology offers an easily collected diagnostic and prognostic tool. In general, while the total blood volume of reptiles varies among species, a safe estimate approximates 5-8% of the total body weight. In a healthy reptile, up to 10% of the total blood volume can be collected without undue stress on the animal. Blood sampling techniques vary between the reptilian groups.

In snakes, venipuncture of the ventral tail vein, the palatine vessels, and the heart commonly deliver adequate samples. For the ventral tail vein, use a 23-26 gauge needle and angle it 45° in a cranial direction just caudal to the hemipenes on the ventral midline. Advance the needle tip to bone and withdraw slightly. Use a needle and syringe pretreated with heparin to prevent coagulation. This technique should be reserved for snakes that weigh over three kilograms. Cardiocentesis can be easily performed with practice. A risk of cardiac tamponade exists and if sterile procedures are not observed, the introduction of pathogens into the cardiovascular system. It is recommended that snakes weigh over 300 grams. On the ventral surface at cranial third of the body, a steady pulsing beat can be observed. Immobilize the heart with your fingers or arch the snake slightly. Use a tuberculin syringe with a 25-30 gauge needle and direct it into the single large ventricle. Use gentle traction to collect the blood. The palatine vessels provide an easily accessible site for collection. The dorsal buccal veins are just medial to the palatine rows of teeth. Do not use these vessels in "mouth rot" cases.

Blood can be collected from lizards via clean toenail clip or venipuncture of the ventral tail vein. For the ventral tail vein, hold the lizard on its back, angle the needle 45° on the ventral midline, caudal to the hemipenes. Advance it to the bone and withdraw slightly for collection.

With turtles and tortoises, a clean toenail clip or venipuncture can be used. Venipuncture sites are the jugular vein, carotid artery, tail vein, femoral venous plexus, axillary vein, and brachial vein. The jugular vein and carotid artery are well-developed on both the right and left sides on the dorsolateral surface of the neck. The jugular vein runs caudal from the level of the tympanic membrane. The carotid artery is deeper, more ventral and parallel to the jugular vein. Use a 23-gauge butterfly catheter for collection. The difficulty involves getting and keeping the neck extended in some species. By pushing in or lightly touching the tortoise's rear legs, the animal may extend its head and neck. Use gentle traction to keep the head extended from the shell. The tail vein can be used on larger tortoises. It is located on the dorsolateral surface.

The use of the femoral venous plexus and axillary vein have been reported in smaller chelonians. The brachial vein was used for blood collection in a Galapagos tortoise<sup>31</sup>. This vein is rarely visualized, so a blind stick will need to be performed. The lymphatics are well developed in the forelimbs of chelonians. It is possible to get a sample contaminated with lymphatic fluid. Cardiac puncture has been reported as a method of blood collection, however, this method requires a hole drilled through the plastron of hard-shelled chelonians.

## **Hematology**

Heparin should be utilized when collecting blood samples from tortoises and possibly other reptiles as well. The use of EDTA will lyse tortoise erythrocytes. Heparin can cause clumping of platelets and leukocytes. After collecting the samples, make the blood smears immediately for best results.

Until enough samples have been examined and compiled for study, it will be difficult for the clinician to determine normal values in a reptile. Serial blood work will help determine the health status in an individual. Keep in mind though, that hematology values vary tremendously with age, reproductive status, season, body temperature, and the nutritional states of the animal.

## **Erythrocytes**

While reptilian erythrocytes eclipse avian and mammalian red blood cells in size, their erythrocytic counts are lower than those of avians and mammals. They are oval to ellipsoid in shape. The oval to round nucleus is centrally positioned in the cell. The nuclear membrane can have markedly irregular borders, a possible association with malnutrition. The nuclear chromatin is condensed and transcriptionally inactive. The erythrocytic cytoplasm is abundant and has a pale eosinophilic color. There may be prominent vacuoles, which may represent autophagic vacuoles from degenerate mitochondria. A common finding in snakes and in the desert tortoise, punctate and basophilic bodies are sometimes associated with the vacuoles. Refractile, transparent areas of the cytoplasm can be artifacts from improper fixation and staining.

Slight polychromasia is a normal finding. Erythrocytes showing polychromasia have a rounder cell shape, a pale blue cytoplasm and a vesicular chromatin pattern to the nucleus. Increased polychromasia and anisocytosis is a typical response to anemia. This dual red blood cell change can be seen in tortoises with post-hibernation anemia. Hypochromic anemia often correlates with poor nutritional status. In the tortoise, immature erythrocytes are smaller than the mature red blood cells. Erythroplasmids (cells with no nucleus) are of minimal significance.

Reptilian erythrocytes may have a life span of up to three years. At the point of senescence, the nucleus swells and becomes amorphous.

### **Leukocytes**

In general, low white blood cell counts could indicate viremias or bacterial septicemias. Leukocytosis will occur in acute inflammatory processes.

### **Heterophils**

Heterophils are like mammalian neutrophils. They become the predominant cell type during natural infections and inflammations. Heterophils are actively phagocytic, large, round cells. Snakes have the largest heterophils of the reptiles. The nucleus in most reptilian heterophils is non-lobed and round. Lobed nuclei occur in some species of lizards: rhynchocephalid saurians (iguanas, chameleons, geckos). The cytoplasm contains elongated eosinophilic granules. In chelonia and crocodilia, the granules are spindle shaped. Snakes have large, pleomorphic granules.

With inflammatory disease in reptiles, the morphological abnormalities are generally more significant than a heterophilia. Toxic changes will appear as a blue cytoplasm, a non-lobed nucleus in those species with lobed nuclei, fewer characteristic cytoplasmic granules, and cytoplasmic vacuolation.

### **Eosinophils**

Reptilian and avian eosinophils share several key characteristics. The nucleus tends to be non-lobed and the cytoplasm is blue. Iguanas have round, bluish granules. Chelonia and crocodilia have round-to-oval granules. True eosinophils have not been identified in snakes and some lizards. A true eosinophilic response is not recognized for most reptiles.

### **Basophils**

Reptile basophils resemble those of avian species. They have dense basophilic granules which sometimes renders cell wall visualization difficult. Basophils are numerous in blood of terrapins.

### **Lymphocytes**

Mammalian and reptilian lymphocytes are similar. They vary in size and may mold around adjacent cells. The nucleus is centrally positioned, round to slightly indented, and the chromatin is heavily clumped or reticular in appearance. The scant cytoplasm stains blue.

### **Monocytes**

The rare monocyte, the largest leukocyte in reptiles, resembles the mammalian monocyte. The cytoplasm may contain vacuoles or tiny eosinophilic granules. The nuclear chromatin is less clumped than in the lymphocyte. In Flap-necked

Chameleons, chlamydia-like and pox-like virus intracytoplasmic inclusions within monocytes have been described<sup>18</sup>.

#### Azurophils

Azurophils are unique to reptiles. They resemble monocytes, but have a distinct eosinophilic staining to the cytoplasm with Romanowsky stains. The cytoplasm shows a tendency to vacuolation. It is postulated that they are derived from monocytes, however, their function is unknown. An association with bacterial infections and azurophilia does exist. These cells are frequently found in snakes.

#### Thrombocytes

Thrombocytes are nucleated much like avian cells. The nucleus is denser, smaller, and rounder than that of the lymphocyte nucleus. The cytoplasm possess an irregular cell border and may be vacuolated. It is colorless to pale grey. Thrombocytes also tend to show aggregation.

#### Blood parasites

The major genera of blood sporozoans are *Haemogregarina*, *Haemoproteus*, *Hepatozoon*, *Karyolysus*, *Plasmodium*, *Schellackia*, and *Simondia*. In general, transmission routes include the bites of leeches, ticks, and other blood-sucking invertebrates, or through the ingestion of mites. The pathology of many of these parasites is unknown. Successful therapy has not been reported.

#### Haemogregarina sp.

These elongate to fusiform oval organisms are present in the red blood cells. They are larger than the cell's nucleus, although the size varies. This basophilic organism has a surrounding clear zone. These parasites are generally considered non-pathogenic, and have been described in the red blood cells of desert tortoises.

#### Plasmodium sp.

Both the schizont and gametocyte stages are present in the peripheral blood cells. Schizonts contain more than one nucleus as well as pigmented granules. Gametocytes are usually large and elongate. The juvenile form appears as a tiny ring at one end of erythrocytes. Larger rings have a central vacuole and irregular shape.

#### Haemoproteus sp.

Only the gametocytes are found in the blood. Asexual reproduction occurs in body organs, especially the liver. The organism occupies the majority of the cytoplasm, leaving the nucleus centrally located. It contains a light magenta, finely granular, pink nucleus.

#### Microfilaria sp.

The clinical significance of microfilaria is not known.

#### Trypanosoma sp.

Trypanosoma transmits through leech or arthropod vectors. They are extra-cellular blood parasites.

#### Leishmania sp.

These parasites are transmitted by the bite or ingestion of an invertebrate intermediate host.

## **Serum Biochemistry**

Reptiles do not show the precise regulatory mechanisms of plasma constituents as seen in birds and mammals. Ambient temperature also causes marked effects on all aspects of reptile physiology. The following selected parameters provide loose guidelines only.

### **Blood Glucose**

This varies tremendously among the reptile groups, and even within individuals. Elevations are seen in young animals and in response to stress. Low values occur with inanition, hepatopathies, septicemias, and endocrinopathies.

### **Calcium**

Calcium levels are difficult to interpret. Decreased serum calcium can indicate a dietary deficiency or parathyroid hyperplasia. Elevations occur in common green iguanas with impending egg laying. Other causes for elevations include dietary calcium excess, excessive oral vitamin D, or renal disease.

### **SGOT (Glutamic-oxaloacetic transaminase or Aspartate aminotransferase (AST))**

This enzyme is found in many tissues: liver, heart muscle, lung, kidney, and blood. Elevations have been observed in tortoises with tissue damage.

### **LDH (Lactic dehydrogenase)**

Many tissues (liver, heart muscle, lung, kidney, blood) also have LDH enzymes.

### **Creatinine**

Creatinine varies greatly among species. Carnivores tend to have higher values. Elevations have been observed in cases of dehydration. This chemistry does not reliably indicate renal disease.

### **Cholesterol**

Cholesterol elevations have been seen in response to starvation in tortoises.

### **BUN (Blood urea nitrogen)**

BUN levels are influenced by dehydration and fasting. In tortoises, urea production may assist in water conservation by elevating plasma osmolality, thereby reducing water loss through the soft integument and increasing water uptake from the bladder. Hibernating Mediterranean tortoises, Texas tortoises and dehydrated desert tortoises show increased BUN<sup>15</sup>.

### **Uric Acid**

Increases appear in renal failure, visceral gout, urinary stasis from cystic calculi, and dehydration. Uric acid will increase for several days postprandially in normal animals. Maximum serum uric acids were found one day after feeding black-rat snakes and monitors which decreased to pre-feeding levels in three to four days<sup>22</sup>. In gila monsters, maximum serum uric acids occurred two days post-feeding and returned to resting levels in four days<sup>22</sup>. Species with slower metabolisms may take longer to reach peak serum uric acid.

## **Cytology**

Cytology is a rapid and simple diagnostic procedure which evaluates the cellular response in disease and identifies the etiological agent if present. The responses include inflammation, hyperplasia, neoplasia, mixed cellular response and normal cellularity.

The equipment used in cytology is minimal. Sample collection requires syringes (6-12 cc), fine gauge needles (22-25 gauge, 1 to 1.5 inch), sterile cotton swabs, sterile rubber or soft plastic tubes, sterile saline, clean microscope slides, and coverslips.

The collection of cells can take place via needle aspirations, washings, scrapings, swabbings, or contact smears. For solid-tissue fine-needle aspirations, insert the needle and attached syringe into the lesion or organ. Redirect the needle position within the tissue several times while maintaining negative pressure, releasing it before removing the needle from the tissue. The sample should remain within the needle lumen and hub. By removing the needle from the syringe, aspirating air into the syringe and reattaching the needle, the sample can be forced out onto a slide. Use a second clean slide to spread the aspirate evenly.

Abdominocentesis fluid samples are usually obtained along the ventral midline. Position and keep the needle parallel to the body wall to avoid penetration of the intestines. The bevel should face outward toward the body wall to avoid aspiration of fat. Abnormal accumulation of fluid will compress the abdominal air sacs, providing access to the peritoneal space. For chelonians, enter the abdominal cavity cranial to the hindlimb.

The site of arthrocentesis sits at the most distended aspect of the joint. Prep the aspiration site as you would for a surgery.

Samples from the trachea, lungs, stomach, and cloaca can be collected by washing with a small amount of sterile physiologic saline. Reaspirate the sample into the syringe. Stained cell preparations, wet mounts, and cultures can be run off the sample. In tracheal wet mounts, exfoliated ciliated epithelial cells may be confused with protozoan parasites. A stomach wash is a common procedure to detect protozoan parasites, especially in snakes.

During a tracheal wash, an appropriate sized soft plastic or rubber tube is inserted through the glottis into the trachea. The tube passes to the level of the bifurcation. Sterile saline is infused, the patient gently rocked to allow mixing and washing of the saline, and the fluid is aspirated. The volume of sterile saline is approximately one percent of the reptile's body weight. The glottis location varies among the major reptile species. In lizards, the glottis generally is found at the base of the tongue, while the location in turtles is behind the base of the tongue. A snake's glottis situates in the front part of the oral cavity immediately behind opening for the tongue. A percutaneous lung wash has been described in chelonians. It involves passing a needle through the inguinal body wall into the lumen of the lung, then flushing and aspirating for the sample<sup>29</sup>.

### **Inflammatory Response**

Inflammation is the reaction of the body to injury. Reptilian inflammatory reaction is similar to avians. A heterophilic inflammatory reaction stems from severe irritation and/or invasion of pathogenic organisms, such as bacteria and fungi. A

mixed-cell inflammatory response occurs subsequently and rapidly after the heterophilic inflammation. Macrophages are attracted to the necrotic material. With a maturing granuloma, multinucleated giant cells and connective tissue cells (ie fibroblasts) are present within the tissue. One example is the chronic upper respiratory disease that afflicts tortoises. Initially, an intermittent serous discharge from the nares is seen. As the disease becomes more chronic, a more tenacious discharge develops. This discharge contains large numbers of inflammatory cells, desquamated epithelial cells, and myriads of bacteria<sup>15</sup>.

### **Noninflammatory Cytology**

A noninflammatory reaction is tissue hyperplasia, which cannot be distinguished from a benign neoplasia. This proliferative process is in response to cellular injury or chronic stimulation. In general, the cellular changes include increased cytoplasmic basophilia, pale, vesicular nuclei, and a uniform cellular appearance with a constant nucleus-to-cytoplasm ratio.

### **Malignant Neoplasia**

The general cellular features include increased cellularity from tissues normally having a lower cellularity and the finding of cells foreign to the tissue sampled. Nuclear changes can encompass anisokaryosis, variable N:C ratios, nuclear pleomorphism, abnormal mitoses, abnormal chromatin patterns, and large pleomorphic or multiple (>4) nucleoli. The cytoplasm will show increased basophilia and vacuolation. Neoplasia is not uncommon in reptiles. One study showed a 17% prevalence rate<sup>26</sup>. The majority of neoplasms were found in snakes and the skin/subcutaneous tissue and liver were the most common organs affected.

### **Parasites**

Whenever possible, captive reptiles should be checked and treated for parasites. Parasites can cause pathology in the host animal, especially when stressed by the rigors of captivity and handling. The difficulty in eliminating reptilian parasites comes from a lack of understanding of the life cycles and the paucity of effective therapeutics. Captivity allows those parasites with direct life cycles to predominate over parasites requiring intermediate hosts.

Gastrointestinal tract parasites can be identified from direct fecal smears, colonic washes, or the standard fecal floats. Protozoans are best diagnosed with the direct smear wet mount or careful examination of fecal sediments. Fecal floats work best for the discovery of helminths. Helminth ova from the reptile and the rodent prey can be similar. A comparison examination of the prey feces may be necessary to determine the source. If the reptile has not recently passed feces for examination, a colonic lavage can be diagnostic. Pass a lubricated French catheter through the cloaca into the colon. The catheter should pass easily. Do not use force, since the walls of the colon and cloaca are relatively thin. Gently flush with normal saline and aspirate.

Keep a good reference handy, as the feces of reptiles normally contain plant and animal artifacts which can be easily mistaken for parasites.

### **Protozoans**

Entamoeba species are pathogenic in lizards and snakes. The organisms cause a caseous colitis and damage to the liver. Unfortunately clinical signs occur late in the disease. In snakes, anorexia is usually the first sign. Other signs include weight loss, vomiting, and blood and/or mucus in the feces. Entamoeba trophozoites are 16  $\mu$  in diameter and the cysts, which contain one to four nuclei, are 11-20  $\mu$  in diameter. There is an inapparent carrier state in chelonians and crocodylians. Transmission follows the ingestion of infective cysts passed in the feces. Cockroaches can carry the cysts between cages if they are present in the environment, multiplying the problem.

Cryptosporidium are small, 4-8  $\mu$ m protozoa that infect the gastrointestinal tract and occasionally the respiratory and biliary tracts of reptiles. It is more commonly seen in snakes, but has been isolated from chameleons, tortoises, and geckos. Clinical signs in snakes include regurgitation and a firm, midbody swelling. Histopathology typically shows a hypertrophic gastritis, atrophy of granular cells and focal mucosal necrosis. The organism sheds through the droppings.

Coccidia are a relatively common parasite seen in colubrids and boids. Eimeria is the primary species, but Caryospora, Isospora, and Sarcocystis are also seen. *Eimeria spp.* usually infects the gall bladder, bile ducts, and intestines. The clinical signs in snakes encompass restlessness, anorexia, and regurgitation. Transmission is by ingestion of sporulated oocysts from contaminated feces or soil.

Ciliates such as *Balantidium sp.* and *Nyctotherus sp.* are found in reptiles. Both of these intestinal parasites are transmitted by the fecal/oral route. Balantidium may be pathogenic in large numbers, but Nyctotherus is generally considered nonpathogenic. The ciliates are more common in tortoises, however, they have been isolated from lizards and snakes.

Flagellates are best diagnosed by a direct smear to observe movement. Most are considered normal intestinal flora. With Trichomonads, the pathogenicity varies with host species. Hexamita is a flagellate that affects the urinary bladder of chelonians.

### **Helminths**

Nematodes are the more common helminth identified in captive reptiles. Cestodes and trematodes are encountered less frequently, possibly due to the complex life cycles of these parasites.

Oxyurid parasites are commonly observed in reptiles. They are the most common helminth of lizards. Generally considered nonpathogenic, they have a direct life cycle and inhabit the host's colon. Both adult worms and eggs pass in the feces.

### **Pentastomids**

Snakes and Pentastomids have one of the oldest known host-parasite relationships. Pentastomids, also known as tongue worms, possess qualities of both annelids and arachids. There are nine genera in snakes, three in lizards, four in crocodiles, and two in turtles. These parasites feed on the host tissue fluids and blood cells. Most species, such as Porocephalus and Armillifer, inhabit the lungs. The larvae and nymphs of Kiricephalus and Raillietiella can also be found in the subcutaneous tissue and the stomach wall. Transmission requires

the ingestion of an infected intermediate mammalian host, such as a rodent, herbivore, carnivore, or nonhuman primate. Humans can also be infected, so owners need to be warned of the zoonotic potential. Most reptiles present no clinical signs. Occasionally hemorrhagic, acute inflammatory, or chronic granulomatous reactions in the colon, liver, or lungs can be found from the migrating larvae, nymphs, and adult Pentastomids. Diagnosis in reptiles necessitates finding the characteristic ova in either the sputum or feces. The ova contain four-legged larvae with retractable claws.

### **Selected External Parasites**

The most common snake mite is *Ophionyssus natricis*. These blood suckers have been incriminated as a carrier of *Aeromonas hydrophilia* and may transmit blood parasites. Large numbers can cause significant blood loss in the host. Careful examination is required to diagnose these parasites. They can be found moving between the scales and in the corners of the eyes. Forcing a snake to crawl through a white towel will dislodge some mites for diagnosis. The mites lay eggs in the immediate environment, so it will be important to treat the snake's enclosure to eliminate this parasite.

Ticks on snakes may be carriers of *Coxiella burnetii* (Q-fever).

### **Selected Bacteria**

Culture collection for bacterial and/or fungal agents can be taken from various sites: the lungs, blood, shell, fluid under scutes, skin, gastrointestinal tract, abscesses, nasal and oral cavities, ocular structures, joints, and bones. One study demonstrates that a culture of the glottis can represent the causative agents of snake pneumonia<sup>13</sup>. Another study stresses the importance of looking for anaerobic bacteria<sup>29</sup>. In over half of the sample sites (subcutaneous and internal abscesses, lungs and coelomic cavity) anaerobic bacteria from the genera of *Bacteroides*, *Fusobacterium*, *Clostridium*, and *Peptostreptococcus* were identified. Although anaerobic bacteria are considered normal flora of the skin, conjunctiva, nasal/oral cavities and digestive tract, they can increase the severity of mixed aerobic and anaerobic infections. For reptiles, the commonly used aminoglycosides are ineffective against anaerobes.

#### ***Aeromonas hydrophilia***

*Aeromonas*, the classical causative agent of infectious stomatitis, pneumonia, and septicemia in snakes, and chelonian pneumonia and septicemia is also associated with septicemias and necrotizing dermatitis in fresh water turtles. In snakes, it is thought to be carried and transmitted by mites or ticks.

#### ***Baneckea chitinovora***

This gram-negative bacillus produces ulcerative shell disease in aquatic turtles. The clinical signs are a loosening and shedding of shell plates, skin ulcers, and a permanently pocked shell. The organism has also been isolated from crayfish, lobsters, and crabs. Disease outbreaks have been traced to the feeding of the turtles with live shrimp<sup>14</sup>. It is recommended that turtles not be mixed with these crustaceans in an exhibit.

#### ***Citrobacter freundii***

Septicemic cutaneous ulcerative disease (SCUD) of chelonians is historically associated with *Citrobacter freundii*. Serratia may be necessary to initiate the

infection. The lesions occur in the skin and on the shell. They develop into deep pockets of caseous material. The prognosis is guarded with visceral abscesses.

#### *Dermatophilus congolensis*

*Dermatophilus* is a gram-positive filamentous-forming bacteria, and the etiologic agent of streptothricosis in mammals. It is the causative agent of hyperkeratotic skin lesions in several species of lizards<sup>14</sup>.

#### *Mycobacteria* spp.

In chelonians, it has been associated with pulmonary and hepatic tubercles, plastronal ulcerations, and granulomatous skin lesions. *Mycobacteria* in constrictors (boa and reticulated python) caused anorexia, ulcerative stomatitis, pneumonia, and subcutaneous nodules. Acid fast organisms are readily identified in cytology samples. There may be a zoonotic potential.

#### *Pasteurella testudinis*

This organism may be involved in upper respiratory disease that compromise tortoises. It will demonstrate bipolar staining on a gram stain.

#### *Pseudomonas* spp.

*Pseudomonas* is one of the most common bacterial organisms associated with oral and respiratory disease in snakes. It is an opportunistic pathogen, causing disease in cases of malnutrition and inadequate husbandry.

#### *Salmonella* spp.

*Salmonella* is commonly isolated from lizards and other reptiles. Many species in this group are considered to be secondary opportunist in reptiles, rather than primary pathogens. Reptiles can be healthy carriers. To detect *Salmonella*, multiple cloacal cultures should be run. Insects have been incriminated as carriers of *Salmonella* to lizards. In a disease outbreak among iguanid lizards, the resulting signs included purulent arthritis and peri-arthritis, peritonitis, and hepatitis<sup>19</sup>. It is a zoonotic bacteria. *Salmonella* infections in young children have been linked to carrier pet reptiles.

#### *Yersinia enterocolitica*

This ubiquitous and widely distributed organism is frequently isolated from domestic, wild and zoo animals, birds and invertebrates. It has zoonotic potential, although only certain biotypes and serotypes are consistently pathogenic for humans. One paper reports the isolation of an organism taken from the intestinal contents of a common garter snake which contained a virulence plasmid<sup>20</sup>.

### **Selected Readings**

1. ALLEMAN AR et al.: Morphologic and cytochemical characteristics of blood cells from the desert tortoise (*Gopherus agassizii*). *Am J Vet Res* 53(9): 1645-1651, 1992.
2. BARNARD SM: Color atlas of reptilian parasites. Part III. Miscellaneous endoparasites and ectoparasites. *Comp Cont Ed* 8(5): 120-123, 1986.

3. BARNARD SM: Color atlas of reptilian parasites. Part I. Protozoans. *Comp Cont Ed* 8(3): 112-115, 1986.
4. BODRI MS: Metastatic large granular cell lymphoma in a boa constrictor. *J Sm Exotic Anim Med* 1(3): 115-116, 1992.
5. CAMPBELL TW: Cytodiagnosis in exotic animal practice parts 1 and 2. *In* Proceedings of the AAHA, Toronto, Canada, 1991, pp 234-242.
6. CAMPBELL TW: Hematology of birds, reptiles, and fish. *In* Proceedings of the AAHA, Toronto, Canada, 1991, pp 230-233.
7. FOWLER ME: Reptiles and amphibians in small animal practice. *In* Proceedings of the AAHA, 1990, pp 594-596.
8. FRYE FL: Biomedical and surgical aspects of captive reptile husbandry. Veterinary Medicine Publishing Company, Edwardsville, Kansas, 1981.
9. GOULD J: Diseases of pet turtles. *In* Proceedings of the AAHA, New Orleans, LA, 1992, pp 306-309.
10. HARVEY-CLARK C: Efficacy of vercom in the treatment of oxyurid nematodes in green iguanas. *Bulletin of ARAV* 1(1): 7-8, 1991.
11. HAWKEY CM et al.: Color Atlas of Comparative Veterinary Hematology. Ames, Iowa, Iowa State University Press, 1989.
12. HENDRIX CM, BLAGBURN BL: Reptilian pentastomiasis: a possible emerging zoonosis. *Comp Cont Ed* 10(1): 93-98, 1988.
13. HILF M et al: A prospective study of upper airway flora in healthy boid snakes and snakes with pneumonia. *J Zoo & Wildlife Med* 21(3): 318-325, 1990.
14. JACOBSEN ER: Reptile dermatology. *In* Miller RE (eds): Current Veterinary Therapy XI Small Animal Practice. Philadelphia, W. B. Saunders Company, 1992, pp 1204-1210.
15. JACOBSEN ER et al: Chronic upper respiratory tract disease of free-ranging desert tortoises (*Xerobates agassizii*). *J Wild Dis* 27(2): 296-316, 1991.
16. JACOBSEN ER: Blood collection techniques in reptiles: laboratory investigations. *In* Fowler ME (eds): Zoo & Wild Animal Medicine Current Therapy 3. Philadelphia, W. B. Saunders Company, 1993, pp 144-152.
17. JACOBSEN ER: Evaluation of the reptile patient. *In* Jacobsen ER, Kollias GV (eds): Exotic Animals; Contemporary Issues in Small Animal Practice. New York, Churchill Livingstone, 1988, pp 1-18.
18. JACOBSEN ER, TELFORD SR: Chlamydial and poxvirus infections of circulating monocytes of a flap-necked chameleon (*Chamaeleo dilepis*). *J Wild Dis* 26(4): 572-576, 1990.
19. KALVIG BA et al: Salmonellosis in laboratory-housed iguanid lizards (*Sceloporus* spp.). *J Wild Dis* 27(4): 551-556, 1991.

20. KWAGA J, IVERSEN JO: Isolation of *Yersinia enterocolitica* (O:5,27 biotype 2) from a common garter snake. *J Wild Dis* 29(1): 127-129, 1993.
21. MADER D: Clinical reptilian anatomy, physiology, and microbiology. *In* *Small Mammal-Reptile Medicine and Surgery for the Practitioner*, Middleton, WI, 1993, pp 1-5 and 56-59.
22. MAIXNER JM et al: Effects of feeding on serum uric acid in captive reptiles. *J Zoo Ani Med* 18(2-3): 62-65, 1987.
23. OROSZ SE et al: Follicle aspiration for the treatment of pre-ovulatory egg binding in a green iguana. *J Sm Exotic Anim Med* 1(4): 161-165, 1992.
24. QUESENBERRY KE et al: Ulcerative stomatitis and subcutaneous granulomas caused by *Mycobacteria chelonae* in a boa constrictor. *J Am Vet Med Assoc* 189(9): 1131-1132, 1986.
25. RAITI P: Occult coccidiosis in a bullsnake, *Pituophis melanoleucus* spp. *Bulletin of ARAV* 3(1): 5-6, 1993.
26. RAMSEY EC, FOWLER M: Reptile neoplasms at the Sacramento Zoo, 1981-1991. *Proceedings of the AAZV/AAWV*, Oakland, CA, 1992, pp 153-155.
27. RIDEOUT BA et al: Mortality of captive tortoises due to viviparous nematodes of the genus *Protractis* (Family *Atractidae*). *J Wild Dis* 23(1): 103-108, 1987.
28. RUSSO EA, BENNETT RA: Reptile Medicine. *Proceedings of the Colorado Veterinary Medical Assoc*, Fort Collins, CO, 1987, pp.219-243.
29. STEWART JS: Anaerobic bacterial infections in reptiles. *J Zoo & Wildlife Med* 21(2): 180-184, 1990.
30. UPTON SJ et al: *Cryptosporidium* spp. in wild and captive reptiles. *J Wild Dis* 25(1): 20-30, 1989.
31. WISSMAN MA, PARSONS B: Abscess in a Galapagos tortoise; case report. *J Sm Exotic Anim Med* 2(2): 60-62, 1993.
32. WRIGHT KM: Medical management of the Solomon Island Prehensile-tailed skink, *Corucia zebrata*. *Bulletin of ARAV* 3(1): 9-17, 1993.
33. ZINKL JG, LOBINGIER RT: Clinical cytology of companion animals, UC Davis Short Course, 1990.