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41
CROCODILIAN DIFFERENTIAL DIAGNOSIS

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Crocodilians as a group have a worldwide distribution and have been able to survive for millions of years. Through time, society has integrated crocodilians species into conservation efforts as a natural resource. Countries such as Australia, India, Mexico, Papua New Guinea, South Africa, and the United States maintain intensive production operations for various species. Alligators, crocodiles, and caimans are all found in farm or ranch scenarios where they are raised for skin and meat. Crocodilian farms maintain their own breeding stock of animals from which they collect eggs every year for hatching. On the other hand, a crocodilian ranch is characterized by the harvest of eggs from the wild. A percentage of the eggs collected is then returned to the wild to maintain the population. Most American Alligators *(Alligator mississippiensis)* are raised in a ranch scenario. Regardless of the methodology, this industry has played an integral role in the conservation of crocodilian species around the world. People now view this species as a natural resource that must be protected for future generations.

Like any other intense production animal system, crocodilian species are affected by an array of diseases in captivity. Some of these diseases may also be observed in wild animals. Stress plays a major role in the occurrence of diseases in captive populations. In this section, we concentrate mostly on diseases found in captive-reared crocodilians, but some also apply to the wild populations. Of all the species, the concentration is on the American Alligator, which is the species harvested in the United States. For purposes of this section, we refer to the group containing all species as crocodilians and then refer to each species by common (crocodiles, caimans, alligators, gharials) and scientific names to avoid confusion.

CAPTIVE HUSBANDRY

Captive husbandry of crocodilians varies with species and country of location. In the United States, the American Alligator industry is also varied between and even within states. In Louisiana, most of the operations are ranches. In Florida, both ranches and farm operations are found. In a ranch operation, buildings are either circular (Figure 41-1) or rectangular with some divisions on the inside to create a number of individual pens. The buildings are completely enclosed with one or two entrances and no source of light. The pens usually allow communication of water and are lined with rubber, fiberglass, or other nonporous material. Heating elements may also be contained within the concrete slab to aid in temperature control. Water heaters are used to maintain temperature when refilling the pens. Water sources can be city water, well water, or bayou water. Most operations do not use a filtration system. Temperature is the only water parameter routinely monitored. The frequency of cleaning the pens can range from three to six times a week depending on the ranch and the size of the animals. A commercial pelleted diet is readily available, and some diets are supplemented with chicken, fish, or nutria. Vitamin supplements are sometimes mixed with the feed. Feed is typically placed on a suspended wooden table in the middle of the pen. Feeding frequency is five to six times per week. A complete history is essential in diagnosis of diseases in a crocodilian operation.

STRESS AND IMMUNOSUPPRESSION

Many diseases of crocodilians are considered to be caused by stress. Stress has been defined as "a physiological answer to a perceived threat that includes, but is not restricted to, increased adrenal secretion."[1] Stress is also thought of as any event that challenges homeostasis, and likely the response to that challenge involves more than an adrenal response. The autonomic nervous system, the hypothalamic adrenal axis, neuropeptides, neurotransmitters, and neuroimmunologic mediators all have a role in the response of the immune system to stress.[2] How stress and immunosuppression are measured is still a subject of controversy in veterinary medicine. No one test can be used to measure stress, but rather physiologic changes are combined to give an idea of what is

FIGURE 41-1 Circular building for raising captive *Alligator mississippiensis.*

involved in a stress response. A number of research studies have examined the stress response in crocodilians. These studies have looked at the stress associated with restraint, long-term corticosterone implants, cold shock, and stocking densities.[3-6] Lance, Morici, and Elsey[7] provide an overview of the physiology and endocrinology of stress in crocodilians. Catecholamines, glucocorticoids, glucose, and lactate have been implicated in the stress response of crocodilians. In addition, an argument is made for immunosuppression on the basis of changes observed in the white blood cells.[3-5,7] The factors that influence stress in crocodilian and reptile species are reviewed by Rooney and Guillette.[1] Enough evidence exists to suggest that stress plays an important role in the physiology of crocodilians, and it may indeed predispose them to illness. Overcrowding, handling, excessive noise, diet changes, temperature irregularities, etc., should all be considered as predisposing or confounding factors of disease. These need to be a consideration with diagnostics and recommendation of treatment for these species.

NONSPECIFIC CLINICAL SIGNS: ANOREXIA, LETHARGY, AND DEATH

The first signs of illness in captive crocodilians are usually nonspecific in nature. These include anorexia, lethargy, and death. The workers notice excess food remaining on the tables from the day before, which is sometimes followed by a perceived change in the behavior of the animals. One should not underestimate these observations because most workers are well tuned to the daily routine and behavior of the animals. A visit to the ranch or farm should be performed during feeding time to avoid additional stress to the animals. This also allows observation of the feeding and water change practices. At this time, a thorough history and a collection of animals for diagnostics and necropsy can be obtained. In addition to routine samples, tissues should be frozen for possible bacterial, fungal, or viral cultures.

The list of differentials for nonspecific clinical signs must be narrowed after diagnostic samples are obtained. However, one must remember that husbandry and disease go hand in hand. Most systemic diseases of captive crocodilians are thought to be secondary in nature. This is especially true for bacterial and fungal diseases because of the environment in which they are maintained. A number of bacterial infections have been diagnosed in crocodilians. The most data available are from *A. mississippiensis* as presented in Table 41-1. This table presents a large number of isolates from diseased and nondiseased animals. Huchzermeyer et al[8] also have extensive data on enteric bacterial and fungal isolates from African Dwarf Crocodiles *(Osteolaemus tetraspis)*.

One bacterium that has been widely studied in reptiles is *Salmonella* sp., in part because of its zoonosis and association with the pet trade. Only a few reports exist of *Mycobacterium* sp. affecting crocodilian species, perhaps because of the difficulties associated with the culture techniques. However, in the author's experience, multiple clinical cases have revealed acid-fast organisms consistent with *Mycobacterium* sp. Their true identity can only be ensured with positive cultures.

More recently, new species of *Mycoplasma*, *Mycoplasma alligatoris* and *Mycoplasma crocodyli*, have been identified.[9,10] Chlamydiosis has also been reported in crocodilian species.[21] Fungal infections occur with some frequency in captive crocodilians. Many of these are opportunistic invaders that affect the integument and respiratory system.

Viral diseases are likely underdiagnosed in reptile medicine because of the challenges in diagnostic techniques and the scarce information about them. Poxvirus and most recently West Nile virus (WNV) have been reported as pathogens in crocodilians. An adenovirus-like infection in captive Nile Crocodiles *(Crocodylus niloticus)* was first identified by Jacobson, Gardiner, and Foggin[12] in 1984. Clinical signs are nonspecific, lethargy and anorexia, although conjunctivitis and blepharitis were observed in one of two crocodiles.[11,12] Hepatitis is thought to be the main effect of adenoviral infection. Intestine, pancreas, and lung are also affected on rare occasions.[11] Horizontal transmission is believed to be more common, but vertical transmission has been postulated.[11] Diagnosis is obtained postmortem, and no treatment regimens have been established.

Coronavirus, influenza C virus, and paramyxovirus have been identified with transmission electron microscope in the feces of crocodilians, but their significance remains to be determined. Finally, evidence exists of seroconversion to paramyxovirus and eastern equine encephalitis virus in crocodilians.[11]

Toxicities are not common in captive crocodilian. However, cases have been found of lead toxicity in alligators fed lead-shot nutria. Clinical signs include weakness, lethargy, anorexia, and death. Alligator ranchers and farmers are now more diligent in inquiring about the source and kill method of nutria before feeding the animals. Another phenomenon seen in captive crocodilian operations is runting. This describes the lack of growth and failure to thrive of some animals within a group. In some operations, animals are separated by size and some buildings contain only the runts. A clear size difference is observed in same-age animals between the runts and the otherwise healthy ones. These animals are not as hardy in the captive environment and are potentially more susceptible to disease. Dominance by other animals, environment, and even incubation factors[13] contribute to the presence of runts.

INTEGUMENTARY DISEASE

Integumentary disease is likely the most important process that affects captive crocodilians. The environment in which they are raised predisposes them to it, and the economic impact can be devastating. Most integumentary lesions in crocodilians usually arise from fighting. Lacerations, abscesses, and draining tracts can all be observed in captive and wild crocodilians (Figure 41-2). Consequently, these open wounds can serve as a nidus for microorganisms, especially fungi and bacteria. An additional factor in captive operations is the accumulation of fatty material in the form of slime on the surface of the water. This occurs when meat supplements are fed in addition to a commercial diet. This slime attaches to the skin of the animals and the enclosure, creating an environment for bacterial and fungal growth. A surfactant disinfectant can be used to reduce the amount of slime on the enclosure. Bacterial dermatitis can lead to septicemia and death; therefore, skin lesions must be recognized early for appropriate therapy. Fungal dermatitis is also common because many fungi thrive in the water column and environment of

Table 41-1 Bacteria Isolated from *Alligator mississippiensis* with and without Signs of Disease

Isolate	Tissue	Clinical Signs/Lesions	Reference
Aeromonas hydrophila	Blood	Yes	29
	Lungs, heart, liver, kidneys, intestines, oral cavity	Yes, no	36
	Lungs, blood	Yes	37
	Eye	Yes	38,39
	Oral cavity, water	No	40
Aeromonas sp.	Lungs	Yes	9
Acinetobacter calcoaceticus	Oral cavity	No	40
Aerobacter radiobacter	Oral cavity	No	40
Bacteroides asaccharolyticus	Oral cavity	No	40
Bacteroides bivius	Oral cavity, water	No	40
Bacteroides loescheii/denticola	Oral cavity, water	No	40
Bacteroides oralis	Oral cavity	No	40
Bacteroides sordellii	Oral cavity	No	40
Bacteroides thetaiotamicron	Oral cavity	No	40
Bacteroides vulgatus	Oral cavity	No	40
Bacteroides sp.	Water	No	40
Citrobacter freundii	Blood	Yes	42
	Oral cavity	No	40
Clostridium bifermentans	Oral cavity, water	No	40
	Lungs	Yes	9
Clostridium clostridioforme	Oral cavity	No	40
Clostridium innoculum	Water	No	40
Clostridium limosum	Oral cavity	No	40
Clostridium sordellii	Oral cavity, water	No	40
Clostridium sporogenes	Blood	Yes	9
Clostridium tetani	Oral cavity	No	40
Clostridium sp.	Blood	Yes	9
Corynebacterium sp.	Tail abscess	Yes	37
Diphtheroid sp.	Oral cavity	No	40
Edwardsiella tarda	Kidney, feces	Yes	41
	Fat body, pericardial fluid	Yes	9
Enterobacter aggiomerans	Blood	Yes	42
Enterobacter cloacae	Oral cavity, water	No	40
Enterobacillus sp.	Lungs	Yes	37
Fusobacterium nucleatum	Oral cavity	No	40
Fusobacterium varium	Oral cavity	No	40
Klebsiella oxytoca	Skin	Yes	42
	Oral cavity	No	40
Klebsiella sp.	Lungs	Yes	25
Micrococcus kristinae	Blood	Yes	29
Moraxella sp.	Oral cavity, water	No	40
Morganella morganii	Blood	Yes	42
	Oral cavity	No	40
	Lung	Yes	9
Mycoplasma alligatoris	Multiple tissues	Yes	29
Pasteurella haemolytica	Oral cavity	No	40
Pasteurella multocida	Lungs	Yes	43
Pasteurella sp.	Oral cavity, water	No	40
Peptococcus magnus	Oral cavity	No	40
Peptococcus prevotii	Oral cavity	No	40
Proteus mirabilis	Blood	Yes	29
Proteus vulgaris	Oral cavity	No	40
	Oviduct	Yes	41
	Blood	Yes	29
	Lung	Yes	9
Proteus sp.	Blood	Yes	42
Pseudomonas cepacia	Oral cavity	No	40
Pseudomonas diminuta	Water	No	40
Pseudomonas fluorescens	Water	No	40
Pseudomonas pickettii	Oral cavity	No	40
Pseudomonas vesicularis	Water	No	40

Continued

Table 41-1 Bacteria Isolated from *Alligator mississippiensis* with and without Signs of Disease—cont'd

Isolate	Tissue	Clinical Signs/Lesions	Reference
Pseudomonas sp.	Lungs, pharynx	Yes	37
	Water	No	40
Salmonella typhimurium	Gastrointestinal tract	Yes	37
Salmonella braenderup, anatum	Cloaca	No	37
Arizona spp.			
Salmonella sp. (subgroup III)	Lung	Yes	44
Serratia marcescens	Skin	Yes	42
Serratia odorifera	Oral cavity	No	40
Staphylococcus aureus	Lungs	Yes	43
Staphylococcus cohnii	Blood	Yes	29
Streptococcus sp., hemolytic	Lungs	Yes	9
Vibrio parahaemolyticus	Blood	Yes	29

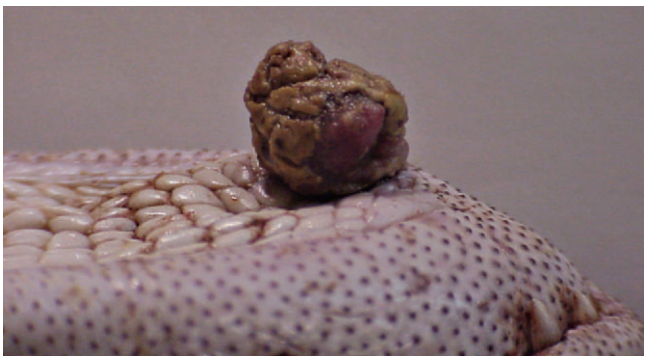

FIGURE 41-2 Mandibular lesion on a captive-reared American Alligator *(A. mississippiensis)*. This lesion involved only skin and did not affect bone.

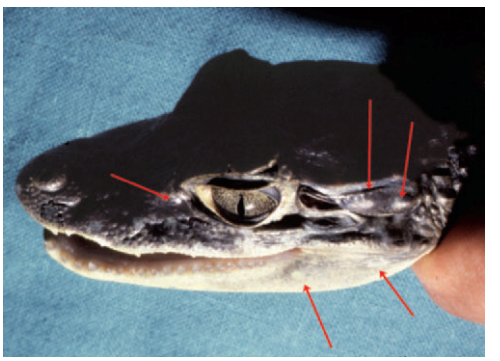

FIGURE 41-3 This caiman (*Caiman* sp.) has pox viral infection. Note the gray patches around the face and eye *(red arrows)*. *(Photograph courtesy F. Frye.)*

captive alligators. In most instances, both bacteria and fungi are present in skin lesions. Culture and sensitivity testing can be frustrating in these cases because of the mixed flora found in the lesions. Nonetheless, antimicrobial therapy should be instituted. Medications can be mixed in the feed to provide adequate dosage. The use of systemic antifungal medications is cost prohibitive in treatment of a large number of animals; therefore, a combination of good hygiene and water treatments with disinfectants is recommended in these situations.

A number of parasites are known to affect crocodilians. *Paratrichosoma* spp. are capillaroid parasites that cause a zigzag lesion on the skin. These lesions are cosmetic, and no evidence has been found of further pathology in affected animals. This parasite is known to affect various crocodile species in the wild and is believed to have a stage of its life-cycle dependent on soil; therefore, it is not observed in captive scenarios where animals are kept on concrete.[11] Finally, pox virus has been reported in various crocodilian species. Regardless of the etiology, good hygiene is essential in the prevention and treatment of integumentary disease in crocodilians. The etiology itself is at times not as important as what conditions predisposed them to the disease.

Dermatophilosis (Brown Spot Disease)

Dermatophilosis or "brown spot disease" causes brown to red lesions usually located between scales. These can be accompanied by ulcerative lesions and are mostly found on the ventral skin. *Dermatophilus* spp. have been implicated with these lesions. Most of the cultures appear to resemble *Dermatophilus congolensis*.[14,15] This condition has occurred in both alligator and crocodile operations. These filamentous bacteria do not respond well to antibiotic therapy in crocodilian operations; therefore, intensive hygiene practices are necessary to prevent and control outbreaks.

Pox Virus

Parapoxvirus or pox-like viruses have been identified in five different crocodilian species: Spectacled Caiman *(Caiman crocodilus fuscus)*,[16,17] Brazilian Caiman *(Caiman crocodilus yacare)*,[18] Nile Crocodile,[19,20] Saltwater Crocodile *(Crocodylus porosus)*,[21] and Freshwater Crocodile *(Crocodylus johnstoni)*.[21] In caimans, pox virus is characterized by 1- to 3-mm–diameter, gray to white, coalescing to macular skin lesions (Figure 41-3). These can be found on the head, palpebrae, maxilla, mandible, limbs, palate, tongue, and gingiva.[16-18] Other signs observed include palpebral and generalized edema. Resolution of clinical signs was observed 6 weeks after improvement of husbandry in one case[17] and after 5 months in another case with no changes in husbandry.[18]

On the other hand, lesions in crocodiles have been described as 2- to 8-mm–diameter, yellow to brown, wart-like, sometimes firm, and unraised to raised nodules with occasional shallow ulcers. These lesions can be found on the head,

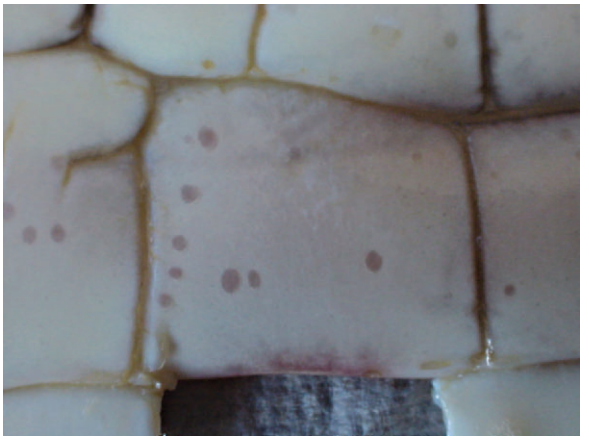

FIGURE 41-4 Gross lesions of lymphohistiocytic proliferative syndrome of alligators. These lesions are sometimes difficult to differentiate from scars and tooth marks.

palpebrae, nostrils, sides of the mouth, oral cavity, limbs, ventral neck, and coelom and at the root of the tail.[19,20] Resolution of lesions was reported to occur as early as 3 to 4 weeks.[19] Light microscopy reveals epithelial hyperplasia, acanthosis, hyperkeratosis, and necrosis, and at times, Borrel and Bollinger's bodies are also visible.[16-20] Secondary bacterial and fungal infections may also be present at the time of diagnosis. Horner[19] reported the use of an autogenous vaccine to treat pox virus in Nile Crocodiles. No specific treatment recommendations exist. Maintaining appropriate husbandry is essential in the prevention and resolution of pox virus in crocodilian farms.

Lymphohistiocytic Proliferative Syndrome of Alligators (PIX Disease)

Lymphohistiocytic proliferative syndrome of alligators (LPSA), also known as PIX disease, has been recently studied in captive-reared alligators from Florida and Louisiana.[22] This production problem mostly affects the quality of the hide and consequently decreases profit for farmers and ranchers. Gross lesions can be seen as multifocal, 1-mm to 2-mm, gray to red foci on the ventral mandibular, abdominal, and sometimes tail scales (Figure 41-4). They can be found on any section of a scale and do not appear concave or convex with respect to the scale's surface. Routine microscopic examination reveals dermal nodular lymphoid proliferation with perivascular cuffing. Similar lesions have also been observed in other tissues besides the skin. One of the problems with identification of the lesions is that they are sometimes not seen until the hides are removed from the animal. Therefore, antemortem identification is not very accurate at this time. The etiology of this syndrome is unknown, but various research projects are examining the possibilities.

Besides the infectious lesions observed on the integument, other potential noninfectious causes exist. A nutritional deficiency or genetics is suspected in the depigmentation of captive alligators. Some farms in Louisiana have animals that are born with normal pigmentation but start becoming white after a few weeks of life (Figure 41-5). These animals thrive well otherwise and do not appear to be runts. No erosions are associated with the lack of pigment. On palpation of the skin, it appears thinner and has a flakier nature, similar to that observed in leucystic alligators. The processing of the hides is not affected by the pigment deficit. Anecdotal reports of improvement of the condition after vitamin supplementation are found, but this has not been documented.

FIGURE 41-5 Skin depigmentation of a captive-reared alligator. This animal was born with normal pigmentation but started to lose pigment after 1 to 2 weeks of age.

NEUROLOGIC DISEASE

Neurologic deficits are not commonly seen in crocodilians and deserve special attention if encountered. The most common neurologic presentation relates to the inability to swim properly. This may include swimming in circles, swimming on one side of the body, or any other abnormal swimming behavior. Out of the water, one may observe lethargy, ataxia, head tilt, and muscle tremors. However, animals may still attempt to bite so one must be cautious when handling them. Anorexia often accompanies the neurologic signs. Any infection that affects the nervous system can lead to similar presentation.

Thiamin deficiencies should be considered in animals fed a frozen fish diet. Signs typically include severe lethargy that leads to coma.

Hypoglycemia has also been reported as a cause of neurologic signs in alligators.[23] These animals have muscle tremors, loss of the righting reflex, and mydriasis. Stress seems to be the main contributing factor.

The most recent etiology to cause neurologic signs in crocodilian species is WNV.

West Nile Virus

West Nile virus is a flavivirus that was found to affect American Alligators during 2001 to 2002.[24] It has also been reported in a Nile Crocodile from Israel.[25] Alligators are believed to first contract WNV after being bitten by a mosquito. However, the current thought is that alligators can have high viremias develop and shed the virus in the feces, leading to horizontal transmission of the virus. This represents an opportunity for zoonosis in captive operations. Some suspect cases exist of alligator to human transmission. A strict building quarantine and hygiene strategies should be implemented to prevent spread to other animals in the facility and to the workers. This is now a reportable disease, and one should contact the state veterinarian and the state office of

FIGURE 41-6 Young Alligator *(Alligator mississippiensis)* with the head tilt typical of those affected with West Nile virus. Notice that it still maintains an aggressive stand with the mouth open.

FIGURE 41-7 Enterocolitis from an alligator diagnosed with West Nile virus. This lesion appeared to cause bloating of the colon and caused difficulties for the alligator to submerge.

public health (see Chapter 79). Thoroughly cooked alligator meat should not represent a source of WNV.

Clinical signs include swimming in circles, head tilt (Figure 41-6), muscle tremors, weakness, lethargy, and anorexia. On necropsy, one may also observe evidence of aspiration and pneumonia. Proliferative enteritis has been diagnosed in a group of alligators with positive results for WNV. The colon lesions tested positive for WNV[26] (Figure 41-7). Clinically, these animals appeared bloated and were unable to submerge in the water. This was likely the result of a blockage caused by the fibrous membrane in the colon. Affected animals in captive operations have ranged in age from 1 month to more than 12 months old. In younger animals, infection is usually severe and acute with as much as a 50% mortality rate. The pattern of deaths is usually seen as a sudden onset of mortalities followed by a peak and subsequent decline in the number of deaths. However, sporadic mortalities may also be seen, especially in older animals. No proposed treatments exist for WNV other than increasing hygiene to prevent the accumulation of feces. Once the infection runs its course, the surviving animals continue to thrive. Definitive diagnosis is best accomplished with reverse transcriptase polymerase chain reaction (RT-PCR) and viral culture of brain and spinal cord. Veterinarians should take additional precautions with necropsies of suspect animals.

Respiratory Disease

This is probably one of the most common presentations of captive crocodilians, second only to integumentary disease. In a review of articles on crocodilian diseases, a fair number show lung lesions on necropsy. Respiratory signs can often be confused with neurologic signs, and a clear distinction must be established. On the other hand, respiratory disease may accompany neurologic disease as a consequence of weakness that leads to aspiration. Clinical signs associated with respiratory disease in crocodilians may include abnormal swimming (either in circles or on one side of the body), dyspnea, tachypnea, excessive basking, nasal discharge, and anorexia, among others. As these animals become weak, the basihyoid valve does not function properly and they can aspirate food or water. Because of the pharyngeal anatomy of crocodilians,

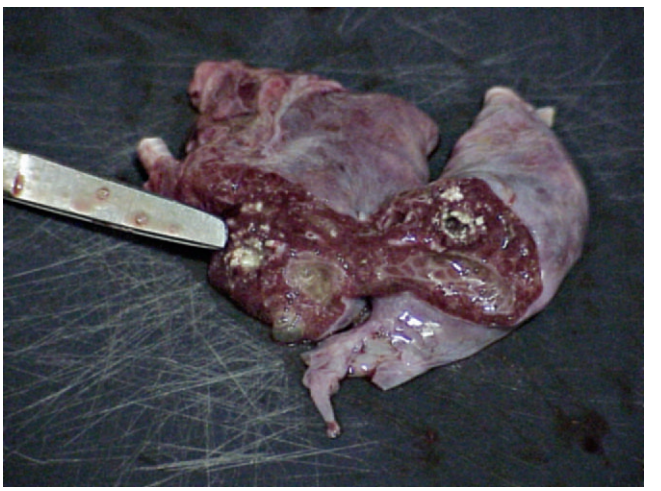

FIGURE 41-8 Caseous material within the bronchi of alligators with respiratory signs. *Klebsiella* sp. susceptible to potentiated sulfa drug was cultured from these lesions, and the animals responded to antibiotic therapy administered with feed.

aspiration is an unlikely event in healthy animals. Therefore, any evidence of it should be indicative of animals with an underlying illness. Most respiratory infections are either bacterial (Figure 41-8) or fungal in origin. A number of rhinitis and pharyngitis syndromes have also been described in some crocodilian species.[11] Fungal infections are perhaps not as commonly diagnosed but still need to be a consideration, especially for captive crocodilians. An early report showed a fungal pneumonia associated with *Beauveria bassiana* in two alligators,[27] and *Fusarium moniliforme* was found in another case.[28] Bacterial and fungal cultures should be obtained from the lungs in cases where respiratory disease is suspected. This allows a choice of appropriate treatment on the basis of sensitivity testing.

Mycoplasmosis

One well-documented respiratory pathogen is *Mycoplasma alligatoris*. Clinical signs are nonspecific and include lethargy,

FIGURE 41-9 Congenital abnormality in an American Alligator *(Alligator mississippiensis)*. This animal was hatched with this deformity and is able to eat and thrive among others in the group.

weakness, anorexia, white ocular discharge, paresis, and edema (facial, periocular, cervical, limbs).[9] Pneumonia, pericarditis, and polyarthritis can be diagnosed on necropsy. Pathogenicity of *M. alligatoris* has been documented for *A. mississippiensis* and for the Broad-nosed Caiman *(Caiman latirostris)*.[29,30] Other crocodilian species closely related to alligators are also potentially susceptible. Treatment should include antimicrobial therapy. Helmick et al.[31] reviewed antimicrobial susceptibility for *M. alligatoris*. A second *Mycoplasma* species, *M. crocodyli*, is known to affect Nile Crocodiles.[10] Lesions are similar to those observed with *M. alligatoris*. Some studies have examined the use of an autogenous vaccine for *M. crocodyli*, but work is still needed to determine its true efficacy.[32,33]

Mycobacteriosis

Another bacterium of interest is *Mycobacterium* sp. Although it is not commonly diagnosed in reptiles, a number of unpublished clinical cases from alligators have shown acid-fast organisms consistent with *Mycobacterium* sp. These animals had evidence of pneumonia on necropsy as shown by multiple white foci, 1 to 4 mm in diameter, on the lung parenchyma.[26] Other cases of pulmonary and enteric mycobacterial infections are mentioned by Youngprapakorn, Ousavaplangchai, and Kanchanapangka.[34] Difficulties of growing *Mycobacterium* sp. make its definitive diagnosis a challenge.

MUSCULOSKELETAL DISEASE

Musculoskeletal disease of crocodilians is commonly seen in captive operations. Many of these are attributed to alterations in the incubation temperature or environment (Figure 41-9). The rest of the musculoskeletal disorders are likely the result of trauma from fighting (Figures 41-10 and 41-11), transport, or restraint. Limb fractures and partial amputations can be seen after altercations. In some farms, observation is possible

FIGURE 41-10 Mandibular fracture in a wild *A. mississippiensis*. This type of lesion is not uncommon in wild animals.

FIGURE 41-11 Rear limb lesion on a wild alligator. Tissue necrosis and part of the bone protruding through skin are seen. Wild animals can recover from these types of lesions, but they can lead to severe septicemia in captive ones.

FIGURE 41-12 Wild alligator with a healed lesion that caused amputation of the distal rear limb.

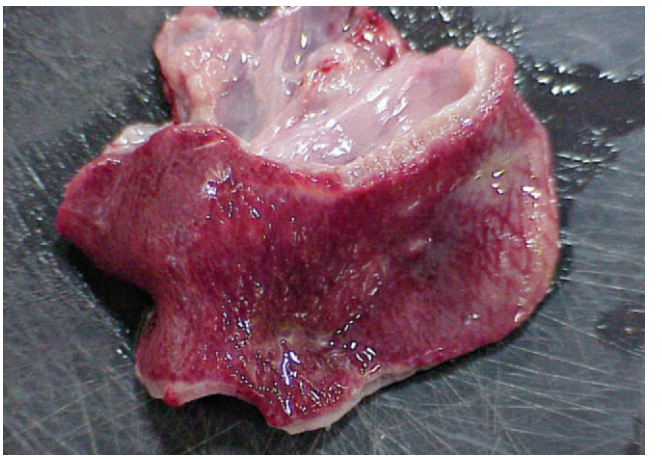

FIGURE 41-13 Enteritis in a captive-reared alligator. Notice the red mucosa.

of animals that have lost limbs after a fight and survived to the point of complete healing. Similar lesions can also be observed in wild alligators (Figure 41-12). These may also lead to nerve or muscle damage and consequent paresis or paralysis. As mentioned in the Respiratory Disease section, *M. alligatoris* and *M. crocodyli* cause polyarthritis, which can be evident antemortem.

Various metabolic bone diseases are seen in young crocodilians and may manifest in different ways depending on the cause (e.g., nutritional, renal). Weakness, lethargy, kyphosis, scoliosis, paresis, tooth decalcification, and other skeletal abnormalities can be observed in crocodilians as well. Only a small number of these abnormalities are observed in most captive operations. Those affected may be runts of the group and have other concurrent disease. This is seen less often as better and improved diets are offered to captive crocodilians. Nonetheless, some operations still may offer no source of calcium in the diet. The innate requirement of ultraviolet B light as a source of vitamin D_3 in crocodilians is not known. They appear to be able to obtain appropriate levels from their diet, but research in this area needs to be performed. The author has seen adult alligators raised in enclosed buildings and offered a pelleted diet with some meat supplement that show no evidence of metabolic disease. However, anecdotal comments from various ranchers indicate that the animals appear to thrive better if exposed to sunlight.

Gout also occurs in crocodilians as either the articular or visceral form. High protein diets, dehydration, and stress are contributing factors to its development. Clinical signs can be nonspecific in nature, but limb paresis/paralysis and joint enlargement may be observed. Ariel, Ladds, and Buenviaje[35] reported a case of gout with concurrent hypovitaminosis A in crocodile hatchlings.

Deficiencies of vitamins A, B, C, or E can also lead to a variety of musculoskeletal disorders. These are not commonly seen when commercial diets are fed in addition to meat products.

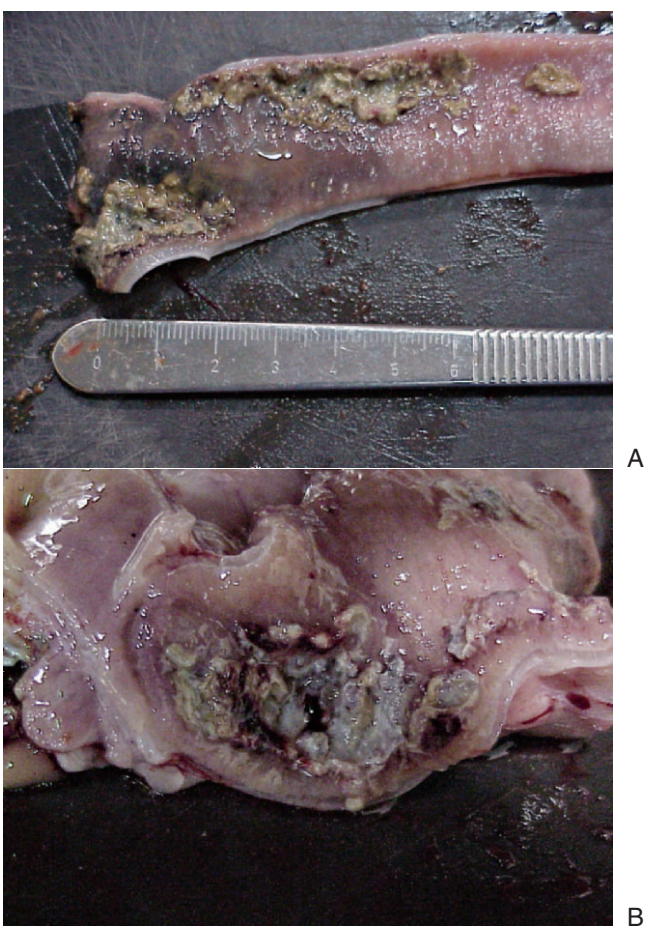

FIGURE 41-14 **A** and **B,** Fibrotic membrane on the intestinal mucosa of a captive-reared alligator. This was an incidental finding for this animal.

GASTROINTESTINAL DISEASE

Anorexia is likely the most common clinical sign associated with gastrointestinal disease in captive crocodilians. Foreign body ingestion, gastric ulcers, enteritis (Figure 41-13), and trauma to the oral cavity can be observed in crocodilians. Ingestion of foreign bodies is more common in wild crocodilians. However, it must also be a differential in captive specimens. Malfunction of water pumps, water filters, or construction can lead to the presence of foreign bodies in the enclosures. These can then be ingested by the animals and

cause severe problems in the case of nails and other sharp objects. A more common process is likely associated with infectious enteritis or septicemia. This is difficult to assess grossly because crocodilians have very thick intestines normally. However, crocodilians appear to have a characteristic response to insult of the gastrointestinal tract. Accumulation of fibrous material or necrotizing lesions is commonly seen on necropsy (Figure 41-14). This reaction is aggressive and can even lead to obstructions caused by the fibrous material itself. Obstruction can also occur with fecal impactions and torsions. Gastric ulcerations and abnormalities of the gastric mucosa are also routinely observed on necropsy and may be associated with stress and diet. Finally, the intestinal tract contains a large amount of Peyer's patches and likely represents a site of aggressive inflammatory response to infectious agents.

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