CAPTIVE MANAGEMENT, BREEDING, AND COMMON MEDICAL PROBLEMS OF THE VEILED CHAMELEON (*Chamaeleo calyptratus*)

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INTRODUCTION

The veiled chameleon (*Chamaeleo calyptratus*) is native to the southwestern Arabian peninsula in western Yemen and southwestern Saudi Arabia. The climate in this region ranges from semi-arid to tropical. Veiled chameleons tend to favor the highlands in these regions where elevations range from 915-3,782 m (3,000-12,400 ft). The highlands contain seasonal riverbeds known as wadis that fill with water during the monsoon rain season (May-September). Alongside these fertile wadis is the preferred habitat for the veiled chameleon. Areas within this range may receive more than 60 in (203 cm) of rain annually. The veiled chameleon is thought to be one of the most hardy chameleon species in captivity. They were first bred in captivity by the San Diego Zoo in 1990 (eggs laid September 1990), which resulted in hatchlings in March 1991. Since that time they have readily reproduced in captivity. Captive bred juveniles are now abundant in the pet trade. Although the veiled chameleon seems to adjust better to captivity than other Old World chameleons, they are still fragile. Failure to provide the specific husbandry needs of these unique lizards will limit their ability to survive.

CAPTIVE HUSBANDRY

It is critical for the reptile veterinarian to review the husbandry practices used by the veiled chameleon owner. Specific recommendations should be made, and proper husbandry should be stressed.

Housing

Like most arboreal chameleon species *C. calyptratus* require ample climbing space and areas within their territory to conceal themselves. Creating a naturalistic environment using large potted trees (*Ficus* sp., *Shefflera* sp., *Philodendron* sp.) in combination with pothos and/or ivy will minimize stress to the chameleons. Variable branch sizes should be provided to help maintain healthy feet. If cages are used, it is important to provide good ventilation and air exchange. This is best accomplished by using screen cages made with polyvinylchloride (PVC) coated galvanized wire, plastic hardware cloth, or finer aluminum screening. Regular metal hardware cloth is not recommended as the chameleons may injure their feet on sharp edges. Alternatively, veiled chameleons can be maintained free in trees that are planted in large wide pots or tubs to keep the lizards from roaming.
Temperature and Lighting

Veiled chameleons prefer warm temperatures. Daytime ambient temperatures should be 26-31°C (80-88°F). They should also have a focal basking site with a temperature range of 35-44°C (95-110°F). Basking heat can be maintained by incandescent bulbs in reflector clamp lamps or ceramic heaters. A thermal gradient should always be maintained within the environment. Nighttime temperatures should be lower, just as they would be in their natural habitats. Temperatures should drop a minimum of 5°C (10°F) at night with a range of nighttime temperatures from 18-24°C (65-75°F).

Ultraviolet (UVB) irradiation appears to be critical for maintaining healthy chameleons. A variety of fluorescent lights are available to provide UVB irradiation. These bulbs should be placed within 30 cm (12 in) or closer to the perching branches. Exposure to natural, unfiltered sunlight is extremely beneficial and may lead to a longer life span for veiled chameleons. Caution should be taken, however, to avoid overheating.

Diet

Veiled chameleons do well on a diet consisting of primarily crickets, but a variety of other insects should also be offered. Mealworms, wax moth larvae, flies, grasshoppers, beetles, butterflies, and moths are some examples. Many of these insects may be obtained by trapping or netting them from the outside. Feeder insects should be fed a relatively balanced diet in order to gut load them prior to feeding them to the chameleons. A variety of whole diets can be used to feed the insects, including psittacine pellets (Harrison's Bird Diets - Adult Lifetime Formula, HBD International, Inc., Delray Beach, FL, 33445, USA), rodent blocks, or tropical fish flakes. Insects can also be fed high vitamin A precursor vegetables such as collard and mustard greens, kale, romaine and red leaf lettuce, grated carrots, and sweet potatoes. A study involving the panther chameleon (Chamaeleo pardalis) revealed that they did well on a diet of crickets gut loaded with a diet consisting of 1-4% calcium content and 50-100 IU of vitamin A and D per gram of cricket food. Additional supplementation can be provided by dusting crickets with a calcium-vitamin D3 powder (Rep-Cal, Rep-Cal Research Labs, Los Gatos, CA, 95031, USA) three to four times weekly and a multivitamin that includes some pre-formed vitamin A (Reptivite, Zoo Med, San Luis Obispo, CA, 93401, USA) once to twice weekly. Insects can be offered by hand or from deep plastic cups or dishes placed in the branches of their trees.

Ferguson has found that panther chameleons can maintain their body weight and reproduce on a diet consisting of 30-50 adult crickets per week. A similar regimen is likely adequate for the veiled chameleon. It is important to keep insect cultures clean and well maintained to ensure healthy feeder insects.

Adult veiled chameleons can also be offered a newborn or weanling mouse weekly. Additionally, veiled chameleons are omnivorous and may accept dark green leafy vegetables such as collard greens, kale, romaine lettuce, and escarole, and they may readily consume the leaves of plants within their enclosure.

Water and Humidity

A variety of watering techniques can be used to visually stimulate veiled chameleons to drink. Misting systems, drip systems, pump spray bottles, melting ice cubes, plastic cups with a small pin hole in the bottom, and water bubbling devices may all work well. It is important to routinely disinfect all...
watering systems (once or twice monthly) as they often become contaminated with bacteria such as *Pseudomonas* spp.\(^\text{19}\). Although *C. calyptratus* is often thought of as a dry desert species much of its native habitat is humid. A humidity range between 50-75\% is appropriate in captivity. This may be accomplished by heavily misting the leaves of the plants in the environment once to twice daily.

**REPRODUCTION**

**Sexing**

Sexual dimorphism is readily apparent in veiled chameleons. Male veiled chameleons have a prominent tarsal spur on the heel which is evident at hatching. With growth and sexual maturity males become longer and leaner than females with a total body length of approximately 30.5-48.3 cm (12-19 in). Males also develop a larger casque than females\(^\text{22}\). Color dimorphism is also evident with maturity, and males tend to be more brightly and variably colored. Females are typically more heavily bodied than males but have a shorter total body length of approximately 20.3-30.5 (8-12 in) and are not as colorful. They typically have a light green background color and horizontal white patches with or without orange/yellow spots\(^\text{2}\).

**Breeding**

It is best to keep males and females separated until they reach sexual maturity at approximately 5-6 mo of age\(^\text{22}\). Females between the ages of 4-8 mo will typically show an interest in breeding by displaying pale blue spots on their lateral body and casque. Males can be bred once they reach a total body length of 30 cm (12 in) or when they reach 6 mo of age. Females may be placed in the males enclosure or vice versa but they should be watched carefully to avoid trauma. Females that are receptive to males will remain passive and continue to display their pale blue spots on their normal green background color. Non-receptive females will typically gape, turn dark black with bright yellow and blue spots and aggressively attack the male. Males react to receptive and non-receptive females by flashing brilliant yellow, green, and orange colors, flattening their bodies laterally, expanding their gular region and bobbing their heads.

Females that are receptive will typically slowly move away from the male who will then pursue the female by grabbing her over the back and mounting her. Copulation may last 10-20 min. The pair may be kept together for 12-48 hr and repeated breedings may occur. Females should be separated from males when they begin to display non-receptive "warming colors" of dark black with yellow and blue spots. Since female veiled chameleons seem to only be receptive for a 10-15 d period Tremper recommends introducing females to males every 5 d once females are showing receptive signs or are mature\(^\text{22}\).

**Oviposition and Fecundity**

Females will usually lay their eggs approximately 30 d after copulation. They may also store sperm from earlier matings for subsequent clutches of eggs\(^\text{22}\). Therefore, females who have been fertilized and have already laid a clutch of eggs may not show the classic "breeding colors" for a subsequent clutch, and may lay a second clutch of eggs 90-120 d after the last oviposition.

Gravid females nearing oviposition will typically become anorexic, restless, and will actively explore their enclosure. A number of nesting sites have proven acceptable for oviposition in veiled chameleons. Deeply potted plants already present in their environment and/or the addition of a
19 L (5 gal) bucket placed adjacent to a chameleon's tree have proven effective. The bucket can be filled with equal parts sand, peat humus, and top soil, and access should be provided with a branch or stick. Females will typically dig a deep burrow and back into it to be completely concealed while laying their eggs. Once oviposition is complete the burrow is filled, and the female typically will rest on top of the covered nest.

Necas reported average clutch sizes for the veiled chameleon in the wild to be 10-12 eggs. Clutch sizes for captive veiled chameleons are much higher (30-70 eggs per clutch), and females can lay consecutive clutches every 90-120 days. This high fecundity in captivity may contribute to the short life span of female veiled chameleons as most do not survive past four or five clutches or 2-3 yr. Males typically have a longer life span in captivity than females and may live for an average of 3-5 yr.

Egg Incubation

Several different methods for successfully incubating veiled chameleon eggs have been described. Stahl and Blackburn have had success with the following protocol: Eggs are placed in small deli cup-sized plastic containers which are filled with Perlite (A. H. Hoffman, Inc., Landisville, PA, 17538, USA) and spring water at a ratio of 1:1 by weight. The eggs were spaced approximately 2.5 cm (1 in) apart. Approximately twenty holes were poked in the lids of the cups for air circulation. The cups were then weighed in grams and were weighed every 14 d during the incubation process to monitor moisture loss. If weight was lost the water was replaced by using a pipette to distribute the water evenly on the Perlite. The eggs were then incubated in total darkness within a temperature controlled incubator. Temperature for incubation was approximately 31°C (88°F) for 12 hr and between 21-23°C (70-74°F) for another 12 hr. At approximately 150 d, 1-3 g (0.04-0.1 oz) of spring water was added to the Perlite to simulate the monsoon season and facilitate hatching. With this method, incubation lengths averaged 170 d. Incubation lengths of veiled chameleon eggs may vary greatly based on techniques.

Neonatal Care

Veiled chameleon hatchlings are approximately 5-7.5 cm (2-3 in) in total body length. One method of raising neonates is to place them in small groups of 3-5 lizards in 38 L (10 gal) aquaria with a 25-40 watt incandescent bulb in a reflector in one corner. One or two fluorescent full spectrum light bulbs are then laid across the top of the aquarium approximately 25-30 cm (12 in) from the lizards. The temperature gradient is maintained similar to adults whereas the juveniles are exposed to 12 hr of light per day. No substrate is used in the bottom of the aquarium. Pothos plants, small branches and plastic plants are used for climbing, perching and camouflage. Humidity is maintained and drinking water is provided by lightly misting the foliage twice daily.

Due to the poor ventilation in the aquaria, scrupulous hygiene must be maintained to avoid respiratory disease. Abate suggests a variety of small mesh screen material (aluminum and plastic) as optimal caging for providing good ventilation. Neonates are fed twice daily with pinhead or one week old crickets and fruit flies. Crickets are gut loaded as described for adults. Crickets and fruit flies are also dusted with a calcium/vitamin D supplement (Rep-Cal) daily and a multivitamin that contains pre-formed vitamin A (Reptivite), twice weekly.

At 2-3 mo of age or at reaching 5-7.5 cm (2-3 in) from the snout to the vent, the young chameleons are best separated into individual enclosures for optimal growth due to increased competition for food, water, and basking sites.
COMMON DISEASES OF THE VEILED CHAMELEON

Most diseases seen in captive veiled chameleons are related to improper husbandry. A thorough review of management practices, and recommending appropriate changes, is critical to resolving most medical conditions.

Metabolic Bone Disease (MBD)

Juvenile (growing), young gravid female and adult veiled chameleons maintained indoors under poor husbandry conditions are the most susceptible to metabolic bone disease. As with other reptiles, the disease is usually the result of low dietary calcium and/or insufficient vitamin D for veiled chameleons. Excessive phosphorus in the diet can also lead to MBD.

Clinical signs of MBD in veiled chameleons include stunted growth, deformed or fractured bones, soft mandibular and maxillary bones, spinal deviations, and paralysis. Radiographs can be used to identify and characterize fractures and the severity of bone involvement. Radiographs also are helpful in monitoring response to therapy.

Treatment involves improving the calcium content of the chameleons diet by the proper gut loading and dusting of feeder insects, and ensuring exposure to ultraviolet light (UVB) through natural unfiltered sunlight or full spectrum bulbs. Patient treatment for MBD is similar to the protocols used for other lizard species as described by Mader. Prognosis can be guarded to good depending on severity and duration. As with other lizards spinal involvement results in a more guarded prognosis.

Hypovitaminosis A

Clinically, veiled chameleons may present with signs of hypovitaminosis A as described by Frye in other reptiles. These chameleons typically have a history of low preformed vitamin A supplementation. Usually insects are only being dusted with a calcium/vitamin D supplement or a multivitamin that has only beta carotene but no preformed vitamin A. Additionally feeder insects may be fed a poor diet.

Clinical signs of hypovitaminosis A include eye problems, respiratory infections, neurological dysfunction, spinal kinking, dysecdysis, and increased formation of hemipenal plugs. Research in the panther chameleon fed a restricted vitamin A diet resulted in these same clinical signs.

Treatment for hypovitaminosis A involves giving a parenteral vitamin A solution (vitamin A palmitate 100,000 IU/ml, vitamin D, 10,000 IU/ml, and vitamin E 20 IU/ml, Mortar and Pestle Pharmacy, Des Moines, IA, 50310 USA) at 2000 IU/30 g body weight p.o. q 7 d x 2 doses. The parenteral drug works well orally and may be safer when used in this manner.

The exact requirements of vitamin A are not known for the veiled chameleon, but Ferguson reports that 37.5 IU of vitamin A given orally seems to be adequate for female panther chameleons. More recent work by Ferguson indicates that vitamin A requirements are likely higher for growing juvenile and reproductively active panther chameleons. Due to concerns about over supplementation of pre-formed vitamin A, several commercial multivitamins have been providing vitamin A precursors such as beta carotene instead of pre-formed vitamin A. However the amounts, type of vitamin A precursor, and ability to utilize these precursors endogenously to manufacture vitamin A is unknown. Therefore, it is recommended to use a multivitamin (for dusting insects) with some pre-formed vitamin A several times weekly to avoid hypovitaminosis A. Additionally feeding insects a beta carotene rich diet, such as green leafy vegetables, carrots and sweet potato, prior to feeding them to the chameleons may be beneficial.
Hypervitaminosis

Organ toxicity associated with fat soluble vitamins A and D is a common nutrition related problem of the veiled chameleon, especially if they are housed indoors. A relationship exists between these two vitamins and their dietary level of supplementation and the amount of ultraviolet exposure in chameleons. The exact requirements of vitamin D and vitamin A are currently unknown, so caution must be used to avoid over supplementation. It is likely that chameleons exposed to natural sunlight will need less supplementation.

**Vitamin A:** Excess vitamin A supplementation may interfere with the metabolism of vitamin D, resulting in metabolic bone disease. Excess vitamin A supplementation may also lead to organ toxicity (renal, hepatic). Gular edema is a common clinical sign of organ dysfunction.

**Vitamin D:** Excess vitamin D supplementation -- especially in combination with calcium -- may result in organ toxicity. Metastatic calcification and gout are common results. Gular edema is a common clinical sign of these problems. Additionally, pseudo-gout has been noted in veiled chameleons fed a heavily supplemented vitamin D and calcium based diet in combination with restricted levels of vitamin A. The pseudo-gout (calcium hydroxyapatite) deposits usually appear as irregular firm swellings over joints in the limbs and on ribs. These lesions are similar to those described by Frye in a chelonian. These swellings must be differentiated from true gout, abscesses/osteomyelitis, and cellulitis. Fine needle aspirate and cytology or biopsy can be used to reach a diagnosis. Radiology may be useful in screening for metastatic calcification and/or pseudo-gout. Bloodwork may indicate extremely elevated plasma calcium values in cases of hypervitaminosis D. Reproductively active female veiled chameleons may also have elevated calcium levels as a normal physiological occurrence. As with iguanas, elevations of phosphorus and a reduction or reversal of the 2:1 calcium:phosphorus ratio in blood plasma is more sensitive than uric acid for detecting renal disease. Liver disease is more difficult to assess from blood chemistry values alone. Bile acids may prove to be helpful, but liver biopsy may be the most effective method of diagnosing liver disease.

Treatment for hypervitaminosis is difficult because the clinical disease is usually well advanced by the time the chameleon is presented (i.e., gular edema with renal failure). Aggressive fluid therapy (20-25 mL/kg per day), evaluating the diet and reducing high levels of fat soluble vitamins, providing unfiltered natural sunlight, and the use of phosphorus binders such as calcium glubionate (Neo-Calgiuron, 230 mg/ml, Sandoz, East Hanover, NJ, 07936, USA) at 1 ml/kg p.o. s.i.d. or b.i.d. may be helpful in managing renal disease.

If hypervitaminosis D and metastatic calcification is suspected then the use of calcitonin (Calcimar, 200 IU/ml, Rhone-Pouleac Rorer, Collegeville, PA, 19426, USA) at 2 IU/kg i.m. s.i.d. may be useful to reduce calcification in soft tissues.

Renal Disease

One of the most common causes of death in veiled chameleons is renal disease. Renal pathology is commonly noted at necropsy and on histopathology. Similar to the green iguana (*Iguana iguana*) the etiology for renal disease may be multifactorial and is not yet well understood.
Possible causes include imbalances in the fat soluble vitamins A and D (see Hypovitaminosis A and Hypervitaminosis), inadequate exposure to UVB irradiation, chronic bacterial infection (possibly from low grade periodontal disease) or exposure to toxins. Additionally, one of the most likely causes of these renal changes could be chronic dehydration. Exposure to low humidity or inadequate watering methods could lead to renal failure, especially in conjunction with these other possible etiologies. Clinical signs are usually vague, but include anorexia, depression, weight loss, and weakness. Other common signs include gular edema, generalized edema, exophthalmia, and enophthalmia (both bilateral). [For other clinical signs, potential diagnostics and possible treatment see Hypervitaminosis section]. Ensuring adequate hydration by maintaining proper humidity, and providing a method to encourage and monitor water intake is critical. Also, "showering" chameleons with a misting system or on a wooden perch in the bathroom shower for 20-30 min once to twice weekly may be helpful in avoiding subclinical dehydration.

Reproductive Problems

**Dystocia:** Veiled chameleons are oviparous (some chameleons are live-bearing) and dystocia is a common problem. There are numerous factors that may predispose females to dystocia, including stress, poor nutritional status, and the lack of a proper nesting site (see Husbandry notes above). A common problem reported by veiled chameleon breeders is dystocia and subsequent death in females that are not bred, but proceed to ovulate and lay unfertilized eggs. Some possible explanations for the increased incidence of dystocia in unfertilized eggs may include overfed young chameleons that have grown and matured too quickly, females with a poor nutritional status (or that may be obese), or females that were housed with or prematurely exposed to males. If veiled chameleons are showing evidence of cycling (see Breeding section) it is best to introduce a male in order to potentially fertilize her eggs. Some breeders, including this author, have had several female veiled chameleons successfully lay a clutch of unfertilized eggs and survive to produce viable eggs and young in subsequent clutches.

Providing exposure to ultraviolet light and adequate levels of vitamin A and vitamin D₃ may be the most important factors in preventing dystocia and other reproductive problems.

Gravid female veiled chameleons typically present with an enlarged abdomen, and gentle palpation of the abdomen usually reveals the presence of eggs. Ultrasound or radiographs can be used to confirm the diagnosis. An egg bound chameleon is usually presented well past her due date and in distress. The females may have already attempted to oviposition and may have laid some — but obviously not all — their eggs or none at all. Oxytocin (Oxytocin injectable, 20 USP units/ml, Phoenix Pharmaceuticals, St. Joseph, MO, 64506, USA) at 10-20 IU/kg i.m. repeated q 12-24 hr, or Vasotocin (Arginine Vasotocin, 5 mg, Sigma Chemical Co., St. Louis, MO, 63178, USA - available as a research drug only) at 0.5-1.0 microgram/kg i.p. q 12-24 hr for several doses may be used with mixed results. Parenteral calcium lactate (Calphosan, 5 mg/ml, Glenwood, Inc., Tenafly, NJ, 07670 USA) and fluid therapy (20-25 ml/kg i.o., i.p., s.c. divided q 24 hr) are usually given several hours prior to using these drugs. Success with medical therapy seems dependent on the duration of the dystocia and the condition of the female upon presentation.

There seems to be a short window of opportunity for these drugs to work. They appear to be most beneficial within several hours or days of the initial oviposition (deposition of part of the clutch) or completion of the nest and attempt to lay eggs. One or two weeks after these events and the drugs are rarely effective. However, the drugs may be worth trying because surgical manipulation is frequently unsuccessful as chameleons are typically presented in an advanced stage. At surgery eggs are typically found to be tightly adhered to the oviducts, which then must also be removed.
Unfortunately, if the oviducts are removed, the ovaries must also be removed as future ovarian ovulation may result in an egg yolk peritonitis. Often females are not strong enough to survive the surgery. It may be best to remove the oviducts and eggs initially then do a second surgical procedure to remove the ovaries when the female is stronger. Typically, isoflurane gas (IsoFlo, Solvay Animal Health, Mendota Heights, MN, 55120, USA) is the only anesthetic used for these surgeries. Retention of eggs will usually result in death, so medical and/or surgical intervention is indicated to avoid the loss of the chameleon.

**Hemipenal trauma:** Male veiled chameleons may present with a prolapsed hemipene due to trauma during courtship or copulation. Additionally, hemipenal plugs may result in prolapse or hemipenal abcessation\(^\text{18}\). Veiled chameleons fed a diet lacking in vitamin A seem prone to hemipenal plugs. Ferguson also found hemipenal plugs common in panther chameleons fed a vitamin A deficient diet\(^\text{8}\).

Treatment of hemipenal prolapse or trauma involves gently cleaning the organ, removing a hemipenal plug if present, and gently replacing the hemipene. Often anesthesia (isoflurane with a mask), topical lidocaine, and hyperosmotics are helpful in replacing the hemipene. One or two vertical sutures across the cloaca over the replaced hemipene can help keep it in place. Sometimes the hemipene must be amputated if it is severely damaged or necrotic. The hemipene is clamped close to the cloaca and a circumferential ligature and a transfixing ligature are used to ligate the vascular supply. Absorbable suture (PDS II, Ethicon Inc., Somervitle, NJ, 08876, USA) is used, and the ligatures placed so they will be hidden within the cloacal fold.

**Respiratory/Sinus/Ocular Infections**

Bacterial infections of the respiratory system are common in the veiled chameleon. Signs of respiratory disease include increased mucus in the oral cavity, increased stridor with breathing, open mouth breathing, and hyperinflation of the lungs. Frequently, the sinuses of the head are involved and bumps or swellings on top of the head between the eyes will often occur. Respiratory and sinus infections are typically associated with eye problems. Discharge from an affected eye(s), swelling in the retrobulbar and periocular areas, and/or holding the eye(s) closed are common ocular signs. When handled or angry, veiled chameleons may make a buzzing noise and their whole body seems to vibrate. This is normal and should not be confused with respiratory disease. Also, like iguanas, veiled chameleons have salt glands in their nares so some sneezing and discharge clear/white fluid from the nares is normal.

Tracheal culture, deep culture of the lining of the sinus, or culturing fluid from sinuses are useful in directing treatment. Typically, Gram negative bacteria such as *Pseudomonas* spp., *Aeromonas* spp., *Klebsiella* spp., and *Proteus* spp., are isolated from these infections\(^\text{19}\). Most of these bacteria occur naturally in their environment and appear to be opportunistic. These problems may also be related to underlying vitamin A deficiency (see Hypovitaminosis A).

Treatment of respiratory infections in veiled chameleons should be aggressive and initiated early. Based on culture and sensitivity tests, the use of a systemic antibiotic should be initiated (see Formulary); swellings involving the sinuses should be opened for drainage; and purulent material should be removed when possible. A variety of ophthalmic drops or ointments can be used on the eyes or in the sinuses -- based on culture and sensitivity. Nebulization therapy with an appropriate antibiotic may also be beneficial in treating chameleons with severe respiratory infections. Generally, antibiotic treatment should last a minimum of 21-30 d or longer. Courses of 6-8 wk may be necessary to prevent recurrence. A review of the diet may indicate the need to supplement with vitamin A (see...
Hypovitaminosis A). Other husbandry factors that may contribute to respiratory/sinus and ocular problems include poor hygiene of water sources and insect cultures, poor ventilation, and improper environmental temperatures.

**Stomatitis/Periodontal Disease**

Stomatitis in veiled chameleons usually involves the mucous membranes along the lips, the commissures of the mouth, or sometimes the tongue. Clinical signs include anorexia, inability to close the mouth completely, loss of symmetry to the mouth, and inability to use the tongue. Prior to treatment, it is useful to collect a deep culture of oral lesions to help guide antimicrobial treatment. Aggressive initial debridement, drainage, and flushing with diluted betadine should be followed by systemic (see Formulary) and topical antimicrobials. Good choices of topical drugs include 1% silver sulfadiazine cream (Thermazine, Sherwood Medical, St. Louis, MO, 63103, USA) or gentamicin sulfate ophthalmic ointment or drops (Schering Plough, Kenilworth, NJ, 07033, USA). The choice of all antimicrobial treatment should be adjusted depending on the results of culture and sensitivity.

Chameleons have acrodont teeth (not rooted, but simply attached to the surface of the mandibular and maxillary bones), which predisposes them to periodontal disease and potentially osteomyelitis. This unique dentition results in a gum line along the lateral surface of the mandibular and maxillary bones which can be readily permeable to bacteria\(^\text{16}\). Regular oral exams should be done to inspect this gum line for signs of discoloration, irregularities in the surface, and loss of tissue. If suspicious lesions are present gentle curettage with dental instrumentation is useful to assess soft tissue and bone involvement. Radiographs may also be useful to determine bone involvement and presence of osteomyelitis. Deep culture of lesions is important for management, and aggressive surgical debridement and curettage may be necessary. Appropriate systemic antimicrobials (minimum of 4-6 wk) and supportive care should be initiated immediately. The prognosis for chameleons with periodontal osteomyelitis and loss of bone is guarded to fair depending on severity and progression. Lifetime dental prophylaxis with an oral cleansing product (Maxigard Oragel, Addison Biological Laboratory, Fayette, MO, 65248, USA) will be necessary to reduce progression and minimize recurrence of osteomyelitis\(^\text{19}\).

**Abscesses/Cellulitis/Osteomyelitis**

Abscesses are common in veiled chameleons and are typically the result of damage to the skin. Trauma from sharp edges in cage materials, bite wounds, or scratches from cage mates or other animals will often result in abscesses. Veiled chameleons tend to be very territorial and aggressive and are most safely housed separately. If they are housed together, a large enclosure with heavy foliage will be necessary to limit interaction. Damaged nails from screen injuries or from pulling chameleons off branches, or dysecdysis of the toes often results in abcessation of toes, subsequent cellulitis, and osteomyelitis.

Abscesses must be treated aggressively. If they progress to cellulitis, joint involvement, and osteomyelitis, the prognosis is guarded.

Treatment involves surgical intervention for aggressive debridement and drainage. Whenever possible, infected bone should be surgically removed. Often, amputation of severely involved limbs may be necessary for the chameleon to recover. Radiology is useful to assess degree of bone and joint involvement. Culture and sensitivity of the abscess wall or deep within the affected tissue is important in determining the appropriate antimicrobial therapy. Four to six weeks or even several months (for infections involving bone) of systemic and topical antimicrobial therapy is usually
necessary to treat these infections. A combination of systemic antimicrobial therapy and initial aggressive flushing with diluted chlorhexidine or betadine may be necessary. For topical treatment of deep wounds involving bone, a solution of DMSO (Domoso, 900 mg/ml, Syntex Animal Health, West Des Moines, IA, 50266, USA) and enrofloxacin (Baytril, 22.7 mg/ml, Bayer Corporation, Shawnee Mission, KS, 66201, USA) using 7.5 ml DMSO and 0.5 ml enrofloxacin or DMSO and amikacin (Amiglyde V, 50 mg/ml, Fort Dodge Laboratories, Fort Dodge, IA, 50501, USA) using 7.5 ml DMSO and 0.25 ml amikacin can be applied once or twice daily to encourage deep local penetration of antibiotics. It is important that the wounds are first flushed or cleaned prior to applying the DMSO solution. Silver sulfadiazine creme (1%) is also a good topical medication, and can be packed into wounds once to twice daily after flushing.

See stomatitis/periodontal disease for information on abscesses of the oral cavity. Abscesses on the head and around the eyes may involve the sinus system (see Respiratory/Sinus/Ocular Infections and Hypovitaminosis A).

Parasitic Infections

Nematodes, cestodes, coccidia, flagellates, and amoeba are all intestinal parasites commonly found in chameleons. Clinical signs of parasitism include weight loss, anorexia, regurgitation and vomiting, and malformed and malodorous stools.

Parasitic infections are not seen as commonly in veiled chameleons because many of them presented to practitioners are now captive bred. But nematodes (primarily oxyurids) and coccidia are often still seen in captive born animals. Flagellates, amoeba, and other nematodes may be present in mixed collections or facilities with poor isolation and quarantine practices.

Wild caught veiled chameleons may present with a variety of these parasites and may also have cestodes.

It is important to have several fecal exams performed on every veiled chameleon that enters a collection. Wild caught veiled chameleons may best be prophylactically treated with both nematocidal and cestocidal drugs (see Formulary). To attempt to ensure that parasites are eliminated, at least three negative fecal samples may be necessary.

A case of cryptosporidiosis was recently described in a panther chameleon and this organism will likely infect veiled chameleons as well. Screening fecal samples for cryptosporidia, especially in animals showing signs of gastrointestinal disease, is recommended. Currently no truly effective drug exists to treat cryptosporidiosis in reptiles and infected chameleons should be isolated or removed from the collection.
FORMULARY

Antibiotics

• Amikacin (Amiglyde V): 2.5-5.0 mg/kg i.m. or s.c. q 48-72 hr. Ensure that the animal is well hydrated prior to and during treatment.

• Enrofloxacin (Baytril): 5-10 mg/kg i.m., s.c., or p.o. q 12-24 hr. Subcutaneous or the intramuscular route initially followed by oral treatment seems to be the most effective method. Be aware that parenteral dosing may cause damage to the skin and/or muscle resulting in skin color changes.

• Ceftazidime (Fortaz, 1 g, Glaxo Pharmaceuticals, Research Triangle Park, NC, 27709, USA): 20-40 mg/kg i.m. or s.c. q 24-48 hr.

• Pipercillin (Piperacil, 2 g, Lederle, Inc., Carolin, 00987, Puerto Rico): 100-200 mg/kg i.m. or s.c. q 24-48 hr.

• Tobramycin: 2.5 mg/kg i.m. q 72 hr.

• Carbenicillin: 100 mg/kg i.m. q 24 hr.

All injections should be given in the anterior one-third of the body. Some of these drugs may cause temporary dark color changes in the skin following an injection. Some of the drugs may be used together if culture and sensitivities indicate it is necessary or to gain a broader spectrum (e.g., enrofloxacin and ceftazidime or amikacin and piperacillin).

Antiparasitic Agents

• Fenbendazole (Panacur, 100 mg/ml, Hoechst-Roussel, Somerville, NJ, 08876, USA): 50-100 mg/kg q 7 d x 3 doses. For nematodes.

• Praziquantel (Droncit, 56.8 mg/ml, Miles, Inc., Shawnee Mission, KS, 66201, USA): 8-10 mg/kg s.c. q 14 d x 2-3 doses. For cestodes.

• Metronidazole (Metronidazole Benzoate, 100 mg/ml, Mortar and Pestle Pharmacy, Des Moines, IA, 50310, USA): 40-60 mg/kg p.o. q 7-14 d x 2-3 doses. For flagellates and amoeba.

• Sulfadimethoxine (Albon, 50 mg/ml, SmithKline Beecham, Weschester, PA, 19380, USA): 90 mg/kg (first day) p.o. followed by 45 mg/kg p.o. s.i.d. x 6 d.

It is not recommended to give more than one or two of the drugs simultaneously to debilitated animals.

• Ivermectin (Ivomec, 10 mg/ml, Merck, Rahway, NJ, 07065, USA) is another antiparasitic agent that may be used in chameleons. However, there have been reports of deaths in chameleons given this drug, so it should be used with caution. In most cases, the antiparasitic agents discussed previously are safer and just as effective. Ivermectin may be useful and necessary when attempting to treat lungworms, such as pentastomids, or migrating nematodes, such as filarids. In this author's experience, a dose of 0.2 mg/kg p.o. q 10-14 d x 2-3 doses has been safe. Perhaps a lower dose may prove to be effective and safe. La Berre has found ivermectin to be safe when given orally at 0.08 mg/kg to Cameroonian chameleons. Do not treat debilitated chameleons with ivermectin.
LITERATURE CITED


