Captive Care of the Desert Tortoise, *Gopherus agassizii*

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ABSTRACT: The desert tortoise, *Gopherus agassizii*, is one of the more common species of tortoises seen by veterinarians practicing in the southwestern United States. Over the past century, many desert tortoises have been taken into captivity. It is currently illegal to remove these tortoises from the wild. Captive populations continue to grow as a result of captive breeding and poaching. Successful long term captive maintenance and reproduction of this species can be achieved with proper diet and husbandry. Medical and surgical considerations for desert tortoises are also addressed.

KEY WORDS: desert tortoise, *Gopherus agassizii*, hibernation, husbandry, medical, surgical problems, reproduction.

INTRODUCTION

The desert tortoise, *Gopherus agassizii*, is a herbivorous reptile ranging through the Mojave and Sonoran deserts of the southwestern United States and southward into the Sinaloan subtropical thornscrub and tropical deciduous forests of Mexico (Germano, *et al*, 1994).

Population declines have been documented in a substantial portion of the desert tortoise's occupied and historical range in the United States. These declines were sufficient to warrant emergency listing of the Mojave desert population in 1989 (United States Fish and Wildlife Service [FWS], 1989), followed by listing as a threatened species through the normal process in 1990 (FWS, 1990). A status determination for the Sonoran desert population in 1990 indicated that, though large gaps in baseline information existed, neither population decline nor known or potential threats were yet sufficient to warrant listing (Barrett and Johnson, 1990, FWS, 1991). Even so, the Sonoran desert tortoise is included on the state list of Wildlife of Special Concern in Arizona (Arizona Game and Fish Department, in prep).

Figure 1. Normal adult desert tortoise, *Gopherus agassizii*, morphology.

A special permit is required to collect desert tortoises from the wild throughout their range. However, due to a combination of long life spans of 50 plus years (Hardy, 1976), ability to survive long periods with sub-optimal care, and relatively high reproductive rate in captivity, many desert tortoises are kept as pets. In states (Arizona, California, Nevada, and Utah) where these tortoises are indigenous to, regulation allows for one tortoise per person to be kept in captivity.

Sonoran and Mojave populations differ genetically, morphologically, and ecologically (Luckenbach, 1982, Lamb, *et al*, 1989, Glenn, *et al*, 1990, Germano, 1993). In general, desert tortoises have a black to tan carapace up to 49 cm in length. The centers of the carapacial scutes are often a lighter orange to yellow color. With age and shell wear, the centers of the carapacial scutes often become smooth and darker gray colored. The carapace is often flat topped and highest caudal to midpoint (Figure 1). The skin of the distal extremities is often gray to brown, while the skin of the proximal extremities and fossas are yellow or gray. The anterior forelimbs are covered with large thick overlapping scales. The caudal thighs are covered with multiple conical scales. Dorsal head scales are often small and irregularly shaped. The iris of the eye is yellow, green, or brown. A pair of well-developed skin (mental) glands are present on the ventral mandible (Figure 2).

Juvenile desert tortoises are not sexually dimorphic. Gender determination of juveniles using endoscopy and measuring blood testosterone levels (Rostal, *et al*, 1994a) have been reported. Sexual dimorphism usually occurs at 10 - 15

Figure 2. Enlarged mental glands on chin of adult male desert tortoise, *Gopherus agassizii.*

years of age. At this time, the inguinal and abdominal scutes regions of the plastron of males begin to get a concavity that facilitates copulation. Additionally in males, the gular scutes or "horns" grow much longer with an upward curve and are used for battling other males during the breeding season (Figure 3). Furthermore, the tails of male tortoises are often thicker and longer than those of females, and the mental glands are often more pronounced in male tortoises during the breeding season.

HOUSING

The best way to achieve ideal husbandry is to mimic a species natural environment. Desert tortoises occupy very diverse habitat depending on their origin. The Mojave population tends to live in flat creosote desert and burrow downward into the ground or sides of creosote mounds. The Sonoran population tends to live on rocky hillsides and arroyos, taking shelter under rocks or vegetation, and in caliche caves. The best captive environment for desert tortoises in the southwestern United States is an outdoor enclosure. This may consist of a specifically built pen or one's backyard. The enclosure should be landscaped with nutritious plants and an area of

Figure 3a. Sexual dimorphism of plastron between male and female desert tortoises, *Gopherus agassizii.* Adult female desert tortoise with flat plastron.

Figure 3b. Adult male desert tortoise, *Gopherus agassizii,* with concavity of plastron and larger gular scutes.

grass (see below under Nutrition for a further discussion on the grasses for the enclosure). The enclosure should be constructed to prevent dogs from entering and tortoises from escaping. A brick "tree well" or retainer wall works well for keeping tortoises confined to a specific area. Placing a 30 - 60 cm submerged barrier or using buried metal flashing bent at a 90° angle inward is usually adequate to prevent escape.

Burrow construction can be accomplished with minimal expense. A hole should be dug into the side of a dry sloping area of the yard or enclosure. Alternatively, a shelter can be constructed at ground level and covered with dirt. Burrow or shelter depth varies greatly in the wild and can range from a few centimeters to 4 to 6 m. In captivity, a 0.5 to 1.5 m depth works well depending on the size of the tortoise. The sides of the burrow should be constructed with bricks or other materials that will support the roof and prevent the sides from caving in. The roof should be constructed of plywood or other strong flat materials. The roof should then be covered with plastic to prevent any wood from becoming wet during the rainy season. The whole shelter is then covered with a minimum of 20 cm of soil for insulation (Figure 4a, 4b). Care should be taken to not construct burrows or shelters in areas where flooding can occur or where the soil remains moist.

In the wild, desert tortoises may share a common burrow, and in captivity, multiple tortoises can be housed together. Adult males should not be housed together as they frequently fight and injure each other.

We do not recommend a permanent water source. Instead, a shallow depression in the ground or grass should be made that allows water to collect one to two times weekly. Desert tortoises have been reported to construct shallow water catchment basins in the wild (Medica, 1980). These areas should be allowed to dry between fillings to decrease the potential for disease and parasite transmission.

Indoor housing is not recommended for adult desert tortoises, however hatchlings may be raised indoors for the first one to three years. This can be accomplished in aquariums or tubs with a substrate of newspaper or coarse topsoil. Exposure to topsoil may be important in establishing cellulolytic bacterial populations in the tortoise hindgut as it is in the green iguana, *Iguana iguana*, another obligate herbivore and hindgut fermenter (Troyer, 1984, Bjorndal, 1987). Thermoregulation is very important for normal physiological function of reptiles. The environment should be maintained with a thermogradient of 25 - 32°C (78 - 90° F) during the day and a uniform 20 - 24° C (68 - 75° F) at night. Heat sources can be supplied using either under-cage heating or a radiant light. Radiant light can be used to mimic the sun and establish photoperiods. The use of ultraviolet B (UVB) radiation is controversial in chelonians and its requirement is unknown. We have observed many juvenile desert tortoises develop metabolic bone disease when a UVB light source was not used, and recommend using it for all growing tortoises housed indoors. Direct sunlight should always be considered the best source of UVB, and periodic exposure to direct sunlight may benefit juvenile tortoises housed indoors. Shelter/hide-boxes should be provided. Water should be offered several times weekly to tortoises housed indoors. Soaking a tortoise in shallow water will often stimulate drinking.

Figure 4a. Burrow constructed for a desert tortotoise, *Gopherus agassizii*.

Figure 4b. Shelter constructed for a desert tortoise, *Gopherus agassizii*.

HIBERNATION

The hibernation period for wild desert tortoises generally begins in October or November and lasts through March or April of the following year (Averill-Murray, *et al*, in press a). We recommend that all healthy tortoises, including juveniles, be hibernated annually. A limited survey of desert tortoise custodians conducted by the Arizona Sonora Desert Museum (Tucson, AZ) Tortoise Adoption Program revealed higher survival rates in hatchlings that were allowed to hibernate their first winter (unpublished data).

Tortoises should be allowed to hibernate in with well-constructed outdoor burrows/hibernaculums. Care should be taken to ensure that burrows remain dry through the winter months. If tortoises are to be hibernated indoors, care must be taken that they are not kept too warm, <18°C (<65°F). Also, due to the relatively low humidity indoors, these tortoises should be rehydrated several times over the winter months. This can be accomplished by allowing the tortoise to slowly warm to room temperature, 18 - 24°C (65 - 75°F). The tortoise can then be soaked in room temperature water for 20 - 30 minutes and returned to its place of hibernation

Low fiber food items should not be offered for two weeks prior to hibernation to prevent pathogenic bacterial, and possibly protozoan, gut colonization. Dried leaves and grasses should be fed, and are often preferred by, tortoises approaching hibernation.

NUTRITION

The diet of wild tortoises in the Sonoran desert consists predominantly of grasses, mallows, and the vine *Janusia* (Van Devender and Schwalbe, 1999), while annual forbs and herbaceous perennials contribute more to the diet of Mojave populations (Jennings, 1993, Esque, 1994). Nutritional analyses of the major forages reported from four studies of free-ranging desert tortoises revealed the overall dry matter content of crude protein at 9.0 - 15.4%, lipids <3%, crude fiber 18.7 - 34.0%, carbohydrate 45.5 - 52.3% and calcium-phosphorus ratios of 3.2 - 5.8:1 (Jarchow, 1987).

The diet for captive tortoises should resemble their wild diet. Grasses are the best sources of nutrition for captive desert tortoises. Bermuda grass, *Cynodon dactylon*, and hybrids can be planted in tortoise enclosures or tortoises can be allowed to graze on lawns. This is an easy inexpensive way to provide a constant source of food. *Dichondra* spp., dandelions, *Taraxacum* spp., and mallows (*Abutilon* spp., *Hibiscus* spp., *Sphaeralcea* spp.) may also be cultivated for food. Tortoises kept outdoors with these food sources do not need supplementation with grocer's produce. Fruits may be offered as an occasional treat, but should be kept to a minimum. The fruits of prickly pear cactus may be offered when in season.

Indoor diets may include dark leafy greens: mustard greens, collard greens, turnip greens, dandelion greens, kale, cilantro, and parsley. Small amounts of other produce can also be offered but should be kept at a minimum. Tortoises need large quantities of fiber in their diet. Cut grass or grass hays should also be offered to provide bulk fiber. Commercially prepared tortoise diets are not recommended as a diet or supplement to the diet due to their frequent high protein and low fiber contents.

REPRODUCTION

Courtship behavior is characterized by the male ramming the female, biting at her exposed limbs, and repeatedly moving into position to mount her (Householder, 1950, Black, 1976, Ruby and Niblick, 1994). Mounting is aided by the concavity in the male's plastron that provides better apposition with the female's carapace. Females can store sperm, so mating events in one summer will produce the next summer's clutch of eggs. There is evidence that suggests an individual clutch may be the product of mating with multiple males (Palmer, *et al*, 1998). Although mating occurs during both spring and summer in the Mojave desert (Black, 1976, Rostal, *et al*, 1994b, Goodlett, *et al*, 1996), females develop shelled eggs following spring emergence and before mating activities (Rostal, *et al*, 1994b). Spring mating may not fertilize eggs but simply stimulate growth and maturation of reproductive organs and gametes in the female tortoises as seen in other chelonian species (Gist, *et al*, 1990).

Ovarian follicles of the desert tortoise in the Mojave desert mature to near-ovulatory size prior to hibernation (Rostal, *et al*, 1994). Thus, Mojave tortoises emerge from hibernation almost ready to ovulate. Ovarian follicles do not appear to mature until after hibernation in the Sonoran desert (Arizona Game and Fish Department, unpublished data), and ovulation does not typically occur until May or June, when Mojave tortoises are already laying their first clutches. Sonoran desert tortoises lay a maximum of one clutch per year, and may not reproduce annually. Mojave tortoises may lay up to three clutches per year (Averill-Murray, *et al*, in press b). Sonoran tortoises lay an average of five eggs (range 1 to 12). In the Mojave desert, average annual reproductive outputs vary from about five to nine eggs per female per year depending on the environment (Karl, 1998, Mueller, *et al*, 1998, Turner, *et al*, 1986, Wallis, *et al*, 1999).

In the Sonoran desert, egg-laying usually occurs near the beginning of the summer rainy season, June and July (Averill-Murray, *et al*, in press b). In the Mojave desert, egg laying occurs earlier in the spring (Henen, 1997, Karl, 1998, Mueller, *et al*, 1998, Turner, *et al*, 1986, Wallis, *et al*, 1999). Females usually deposit their eggs inside burrows with adequate soil development that allows excavation of a nest cavity.

Egg incubation is approximately 90 days, with eggs usually hatching in September and October. Some eggs apparently over-winter in the nest in the Mojave desert, and possibly the Sonoran desert, with hatchlings emerging in the spring (Luckenbach, 1982). Hatchlings measure 43 to 48 mm carapace length when they emerge from the nest and are relatively soft and vulnerable. Like other chelonians, gender is determined by incubation temperature in the nest. In the northeastern Mojave desert, nest temperatures >32°C (>90°F) produced females while lower temperatures (<32°C) <90°F) produced males (Spotila, *et al*, 1994). The threshold incubation temperature may vary across the range of the desert tortoise, as it does in other widely ranging chelonian species (Bull, *et al*, 1982).

MEDICAL PROBLEMS, TREATMENTS, AND SURGERY

Upper respiratory tract disease (URTD) is one of the most common medical conditions observed in the authors' (JDJ and JLJ) practices. The primary causative agents of this disease are *Mycoplasma* spp. (Jacobson, *et al*, 1991, Jacobson, 1994, Jacobson, 1997, Schumacher, *et al*, 1994). Mycoplasmosis can cause a significant immune-mediated inflammatory response of the mucous membranes (Jacobson, 1997). Rhinitis, conjunctivitis, nasal discharge and erosion, and choanal inflammation are the most common clinical signs of URTD (Johnson, *et al*, 1998), with pneumonia occuring in severe cases (Figure 5). Affected tortoises are often anorexic, lethargic, and cachexic. Diagnosis should be made based on clinical signs, and *Mycoplasma* culture, ELISA, or PCR testing. Treatment with appropriate systemic antibiotics is often successful. Administration of macrolides, tetracyclines, or fluoroquinalones has been suggested (Johnson, *et al*, 1998). For tortoises that allow oral administration of medications, clarithromycin (Biaxin, 50 mg/ml, Abbott Laboratories Inc., Abbott Park, IL) can be used at 15 mg/kg PO q 48 hr (Wimsatt, *et al*, 1999). Tortoises not allowing oral dosing can be parenterally treated with enrofloxacin (Baytril 22.7 mg/ml or 100 mg/ml, Bayer Corporation, Shawnee Mission, KS) at a dose of 5 mg/kg IM q 48 - 72 hr (Johnson, *et al*, 1998). Flushing the choanae is also often of benefit in decreasing morbidity. Due to a major part of the disease being immune-mediated in nature, we recommend retrograde flushing of the choanae with a steroid plus antibiotic combination (Gentocin Durafilm Solution, Schering-Plough Animal Health Corp., Kenilworth, NJ).

Figure 5. Nasal discharge from a desert tortoise, *Gopherus agassizii*, affected with URTD.

Figure 6. *Tachygonetria* spp. is an oxyurid that is normal in desert tortoises, *Gopherus agassizii*. 40X magnification.

Sedation is sometimes necessary for examination or procedures. Ketamine HCl (Ketaject 100 mg/ml, Phoenix Pharmaceuticals Inc., St Joseph, MO) can be used at doses of 15 - 20 mg/kg IM by itself, or in combination with diazepam (Diazepam Injection USP, 5 mg/ml, Elkins-Sinn Inc., Cherry Hill, NJ) 0.2 - 1.0 mg/kg IM. For induction of anesthesia, propofol (Propoflo 10 mg/ml, Abbott Laboratories Inc., North Chicago, IL) 5 - 10 mg/kg IV is preferred. Direct intubation and administration of anesthetic gas via positive pressure ventilation to effect can be used for tortoises that allow head restraint and opening of the mouth. The use of butorphanol (Torbugesic 10 mg/ml, Fort Dodge Animal Health, Ft Dodge, IA) 0.4 - 1.0 mg/kg IM pre or postoperatively should be considered if analgesia is indicated.

Shell fractures should be managed on a case-by-case basis. Contaminated wounds should be cleaned with appropriate antiseptics, debrided, and managed as an open wound until no infection is present. If the coelomic cavity has been opened, thorough lavaging and flushing of the cavity with sterile saline should be performed. Appropriate systemic antibiotic therapy should be used. Stabilization of shell fractures can be accomplished via pins and wires or epoxy/fiberglass bridging.

Dog bite trauma is a common problem of desert tortoises housed with canines in the same yard. Each case can present new and challenging aspects of orthopedic and soft tissue repair. Frequently recovery is slow and morbidity and mortality are high. It is not recommended to allow tortoise and dogs to cohabit the same area.

Hyperthermia can occur when tortoises are unable to move to cooler areas during high daytime temperatures. This can happen when tortoises are flipped over on their carapace for prolonged periods or when inappropriate enclosures do not provide the opportunity to escape the midday heat. Signs associated with hyperthermia include lethargy, weakness, edema, ptyalism, and neurological signs. Damage of the cerebellum due to cerebral edema can cause permanent or long-term ataxia. Renal failure may occur as a sequella to hyperthermia. Treatment should include slow cooling, steroids, and fluid therapy up to 40 ml/kg (see below for further discussion of route and type of fluids recommended). Dexamethasone sodium phosphate (Dexamethasone Sodium Phosphate injection, USP 4 mg/ml, American Regent Laboratories Inc., Shirley, NY) 0.1 - 0.25 mg/kg IM or IV should be administered. Follow-up blood work should be performed to monitor for renal disease.

A fecal examination should be performed annually and on all tortoises presenting for medical problems. Oxyurids exist as normal, non-pathogenic intestinal parasites in most wild and captive desert tortoises. The oxyurid *Tachygonetria* appears to be ubiquitous in free-ranging Sonoran desert tortoises (Dickinson, *et al*, in press), and treatment is not indicated (Figure 6). Other nematode, protozoan, cestode, and trematode parasites may be identified on fecal examination and should be treated accordingly. *Hexamita* (*Spironucleus* spp.) is a relatively common protozoan parasite that can cause renal failure. External parasites may also present problems for desert tortoises. Ticks may be found feeding on both wild and captive tortoises. Ticks should be manually removed and treated with pesticides safe for use in tortoises. Permethrin (Permectin II, Aspen Veterinary Products, Kansas City, MO) diluted to a 0.01% has been shown to be safe and effective (Burridge, 2000). Enclosures and burrows should also be treated with cyfluthrin (Tempo, Bayer Corp., Kansas City, MO). Tortoises should be removed from the environment and not returned until the spray has completely dried. Myiasis can occur in debilitated tortoises or when damage to the integument has occurred. Tortoises should not be left outside when open wounds are present.

Cystic calculi are frequently reported in desert tortoise (Frye, 1972, Mangone and Johnson, 1998, Mader, 1999). While often-incidental findings during examination, cystic calculi can cause cystitis, dystocia, obstipation, and hind limb dysfunction. Cystic calculi can often be palpated through the prefemoral fossa when the tortoise is held so that gravitational forces bring the calculi closer to the fossa. The calculi are predominantly composed of uric acid and are easily visualized on radiographs. The etiology of cystic calculi in tortoises

is unknown, and may be multiple. The incidence of cystic calculi is much higher in captive tortoises, and therefore diet and hydration status have been implicated as potential causes for their formation. Cystotomy and stone removal can be performed via plastron osteotomy or a soft tissue approach through the prefemoral fossa (Mangone and Johnson, 1998). Celiotomy may be necessary for a variety of other conditions including, intestinal impaction, obstruction, foreign bodies, and dystocia. Surgical approach through the prefemoral fossa limits the exposure to the coelomic cavity, however morbidity caused by surgery is less and recovery time is much shorter. When applicable, the prefemoral fossa celiotomy should be used (Figure 7).

The primary site for blood collection from desert tortoise for purposes of hematology and biochemical analysis should be the jugular vein. Most captive desert tortoises will allow manual restraint of the head and jugular venipuncture without significant resistance. Blood can also be taken from the brachial vein, however lymph dilution is common at this site. Biochemical and hematological reference ranges are reported for desert tortoises with normal variation occuring both seasonally and between sexes (Roskopf, 1982, Dickinson, 1995, Dickinson, 1996, Christopher, 1999). Erythrocyte and leukocyte morphology is similar to those of other tortoise species. Erythrocytes of desert tortoises frequently contain an intracytoplasmic body considered to be a degenerative organelle (Alleman, *et al*, 1992).

Nutritional secondary osteodystrophy and metabolic bone disease of tortoises are well discussed in literature (Scott, 1992, Boyer, 1996, Highfield, 1996). Disorders are seen most frequently in juvenile desert tortoises housed indoors, without access to UVB radiant light, and fed an improper diet. Affected juvenile tortoises have soft shells. The disorder often results in a flattened carapace and excessive pyramiding of carapacial scutes as the tortoise grows (Figure 8). Diagnosis is frequently made based on clinical signs and history. Plasma calcium and phosphorus levels can be checked to verify the presumptive diagnosis. The condition usually resolves when proper diet and husbandry are initiated.

Hypovitaminosis A can occur in desert tortoises. Desert tortoises are highly susceptible to hypervitaminosis A. Parenteral vitamin A should not be used in desert tortoises as it frequently results in skin sloughing. Correction of diet is usually sufficient to correct deficiency.

Ultrasonography is a useful diagnostic tool in helping diagnose many disease processes. Anatomical approaches and clinical applications of ultrasonography of desert tortoises are reported (Pennink, *et al*, 1991). Visualization of the heart, liver, gallbladder, urinary bladder, intestines, kidneys, and gonads can be achieved. Multiple reproductive studies of desert tortoises have been performed using ultrasound to identify follicle and egg development (Rostal, *et al*, 1994, Christopher, *et al*, 1999).

Appropriate supportive care should be provided to all sick tortoises. Replacement fluid therapy should always be initiated when dehydration or decreased water intake is present (Figure 9). Fluids can be provided by soaking, or via oral, epicoelomic, intracoelomic, or intraosseus administration. Epicoelomic administration is accomplished by inserting the needle caudoventral to the axilla angling towards the prefemoral fossa along the inside of the plastron (Figure 10).

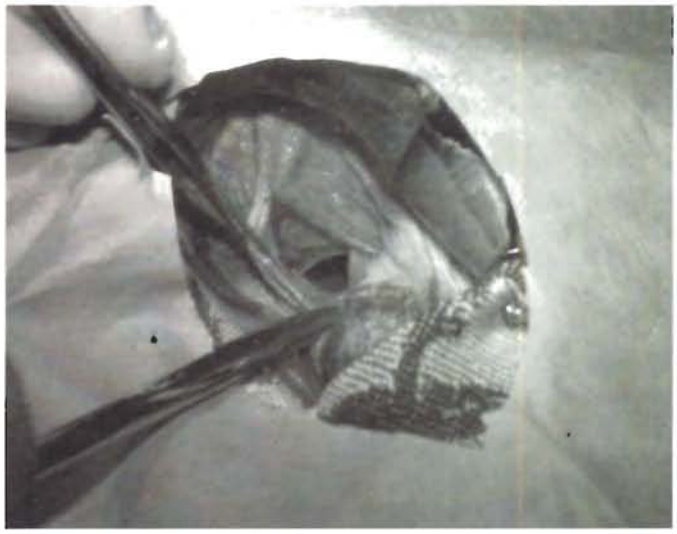

Figure 7. Soft tissue celiotomy approach in the prefemoral fossa.

Figure 8. Abnormal appearance of an adult desert tortoise with metabolic bone disease.

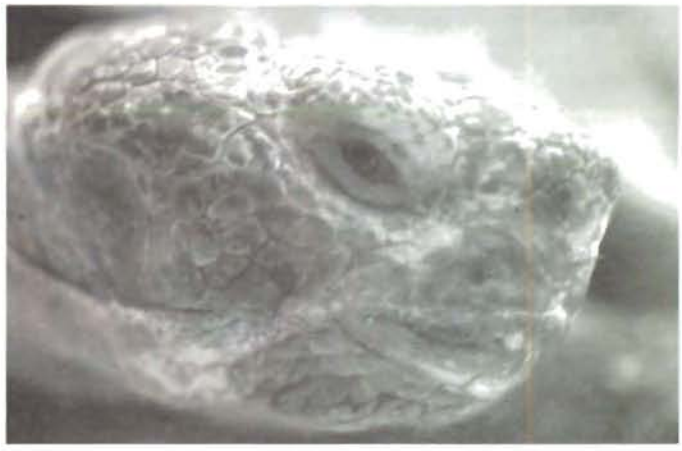

Figure 9. Dehydration in an adult desert tortoise. Note the sunken in appearance of the eye.

Fluids are injected into the potential space between the plastron and coelomic membrane. Intraosseus catheters should be placed in the cranial pillar of the shell (Figure 11). An appropriate hole is drilled into the pillar and a hypodermic or spinal needle is inserted and secured in place with epoxy. A 1:1 mix-

ture of Dextrose 5% in water or 2.5% dextrose in 0.45% saline and a non-lactated electrolyte replacement solution (eg, Normasol-R, Abbott Laboratories, North Chicago, IL) should be used (Prezant and Jarchow, 1997). Fluid replacement should be provided at a rate of 15 - 25 ml/kg/day and can be doubled initially for critically ill patients (Jarchow, 1988). Nutritional support should be provided to anorexic tortoises either by stomach gavage or via an esophagostomy tube. Tortoises should be started on small quantities of food initially to prevent refeeding syndrome from occuring (Donoghue and Langenberg, 1996). The authors recommend feeding a commercial diet (Critical Care for Herbivores, Oxbow Pet Products, Murdock, NE) to anorexic tortoises. Desert tortoises should be housed in an environment where they are able to maintain their body temperatures at or near their preferred body temperature during convalescent periods. When possible, tortoises should be given access to direct unfiltered sunlight. Early aggressive supportive care practices result in less morbidity and a faster recovery for most patients.

Figure 10. Location of administration of epicoelomic fluids under pectoral muscles and above plastron.

Figure 11. Intraosseus catheter in the cranial pillar of the shell.

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CLIENT HANDOUT

Captive Care of the Desert Tortoise, *Gopherus agassizii*

Jay D. Johnson, DVM, James L. Jarchow, DVM, Roy Averill-Murray, MS

Housing

- Tortoises should be housed in outdoor enclosures whenever possible.
- A backyard or enclosed area of the yard works well.
- Make sure the enclosure is escape proof by digging a barrier structure deep into the ground along the perimeter of the enclosure or by placing a layer of sheet metal bent at a 90° angle inward under ground level.
- The enclosure can be landscaped with nutritious vegetation.
- Do not allow tortoises to inhabit the same yard with dogs. Dogs will often chew on tortoises.
- Burrows can be constructed in many ways. A 0.5 - 1.5 m (2 - 4 ft) deep burrow can be dug into the ground, the side of a sloping area of the enclosure, or built upward from ground level. The sides can be lined with bricks for support. The top can be covered with wood or other materials and covered with plastic. The structure should then be covered with enough soil, 30 cm (1 ft), to provide adequate insulation from the cold winter and hot summer temperatures.
- If indoor housing is used, aquariums or plastic tubs can be used. Use an overhead lamp to provide a heat source keeping the temperatures ranging from 25 - 32° C (78 - 90° F). A gradient should exist in the cage allowing the tortoise to select warmer or cooler temperatures, as it desires. An ultraviolet light source specifically indicated for reptiles should also be placed directly over the cage. The cage should be allowed to cool at night to 20 - 24° C (68 - 75° F). Newspaper or coarse dirt can be used as cage substrate. Dirt may be an important source of bacteria needed for digestion for hatchling tortoises. A hiding box should also be provided.

Diet

- Desert tortoises are herbivorous, meaning they only eat plants. They also require large amounts of fiber in their diet for normal digestion. They should not be fed anything that is not of plant origin.
- An area of Bermuda grass should be planted within the enclosure. Bermuda grass is one of the best food items you can provide. Dichondra, dandelions, and mallows can also be planted and are a good source of nutrition.
- For tortoises housed indoors a mixture of dark leafy greens (mustards, collards, kale, spinach, escrole, parsley, and cilantro) and cut grass or grass hay should be offered daily. A small amount of other vegetables and fruits can be given on occasion.
- Water should be provided one to two times weekly in a dug out area of soil or in a depression in the grass and allowed to dry between waterings. Permanent water sources are not recommended.
- Commercial pelleted diets are not recommended.
- Supplementation of calcium and vitamins are not necessary for tortoises feeding on grass in outdoor enclosures. It is also not necessary for tortoises housed indoors that have access to UV light and are fed a diet that is predominantly a mixture of dark leafy greens and grass.

Hibernation

- Hibernation is very important for long-term health.
- In the desert regions of the southwestern United States, tortoises should be allowed to hibernate outside in their burrows.
- Hibernation generally ranges from October through March or April of the following year.
- If hibernating tortoises indoors, care should be taken not to allow the tortoise to be kept too warm. Tortoises should be maintained between 10 - 18°C (50 - 65°F).
- Caution should also be taken that burrows do not become wet or remain damp during hibernation.
- Tortoises hibernated indoors can become dehydrated due to the lower humidity level of the house. These tortoises should be allowed to warm to room temperature and soaked in a room temperature 18 - 24°C (65 - 75°F) water bath monthly during hibernation.

Veterinary Care

- Tortoises should be routinely examined every fall prior to hibernation.
- Microscopic evaluation of feces for parasites should also be performed annually.
- Tortoises should be examined by a veterinarian knowledgeable about reptiles if you notice nasal discharge, weight loss, diarrhea, anorexia, regurgitation, swollen eyes, soft shells, wounds, or other concerning conditions.
- Speak with your reptile veterinarian concerning *Salmonella* bacteria in reptiles and preventative measures that can be taken to limit transmission to people.