WORLD ANIMAL PROTECTION

Animal welfare review

of reptile and amphibian species

Contents

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Executive summary

The keeping of reptiles and amphibians as pets burgeoned in the 1980s and 1990s, and by 1997 566,000 Green Iguanas (*Iguana iguana*), 94,000 Ball Pythons (*Python regius*) and 29,000 Boa Constrictors (*Boa constrictor constrictor*) were imported to the United States.[1] By 2000, it was estimated by the American Pet Product Manufacturers Association that more than 3.9 million households in the United States had one or more reptiles or amphibians as pets, representing a 44% increase in ownership from 1998.[2] Now, the American Pet Products Association's 2023-2024 National Pet Owners Survey estimates reptile and amphibian pet ownership at 6 million households.[3]

The great upsurge in reptile and amphibian pet ownership coincided with the advent of the internet and subsequent social media platforms. This fostered the creation of digital communities for pet owners, breeders, and reptile expo vendors.[4, 5, 6] Thousands of digital communities currently exist on platforms such as Facebook, Reddit, and Pinterest, stand-alone websites, and YouTube channels devoted to individual species or groups of animals such as tortoises and snakes, including their specific diseases.[7] These outlets implied a possible benefit to reptile and amphibian welfare by increasing the exchange of current care standards, nutritional information, disease identification and treatment, and even rehoming – yet the quality of information greatly varies and is often incorrect and often harmful to these animals. The same proliferation of digital sources has also increased individual access to reptiles and amphibians; increased contact of breeders to potential buyers; helped normalized exotic pet keeping; and created an easy platform for trafficking illegal animals.[8] By normalizing the keeping of wild animals as pets, digital communities may also influence how wild animals living in their wild habitats are perceived by humans.[9, 10, 11]

There is an ongoing debate as to whether the needs of reptiles and amphibians can be met in captivity,[12, 13, 14] especially considering these animals are ectotherms and dependent on environmental conditions to run all physiological and behavioural processes.[15] Further, reptiles and amphibians are not domesticated per se, and have not undergone genetic selection that enhances their survival when living in captivity near or with humans.[16]

Our understanding of the intricate behavioral patterns among reptiles and amphibians is undergoing rapid expansion. Reports have highlighted instances of play behavior, alongside the ethological necessity for movement, and foraging activities.[17, 18, 19] Substantial evidence has invalidated previously established anecdotal or folkloric notions, which asserted that reptiles and amphibians are predominantly unsocial, sedentary creatures, and do not necessitate extensive or varied habitats.[20, 21] Nevertheless, the depth of knowledge required for addressing the environmental needs of the numerous reptile and amphibian species held in captivity is of considerable enormity. Even well-funded zoos seemingly have difficulty providing for the requirements of these animals, still less a typical pet owner.[18, 22] For instance, despite the presence of a multitude of reptile and amphibians species within the pet trade (estimated at 3,943 species, 36% of all known reptile species,[23, 24] only a fraction of these species have data from *in situ* (in their natural wild home) animal studies for temperature, humidity, UVB lighting, or for home-and use-range areas that would inform the environmental and spatial needs of these animals.[25]

Factors crucial for survival, such as nutrition, environment, and health, exert a profound influence on an animal's state, or sense of well-being, generating a complex network impacting the mental well-being and overall welfare of animals.[26, 27, 28] In the context of captive animals, especially ectothermic ones, these determinants significantly hinge on the practices of animal husbandry. Consequently, estimates that in excess of 70% of reptilian and amphibian illnesses are due to inadequate husbandry underscore the association between compromised welfare conditions, and nutritional and environmental facets.[29, 30] Health concerns stemming from husbandry include but are not limited to metabolic bone diseases linked to suboptimal diet, lighting, and temperature; facial and head injuries from interactions with enclosure boundaries; thermal injuries; predation-related bites; and gastrointestinal obstructions resulting from substrate consumption or sedentary behavior.[31, 32, 33, 34] Reptiles and amphibians also face emerging illnesses including infectious (bacterial, viral, fungal) and neurological diseases,[35, 36, 37, 38, 39] likely due to poor sanitation in breeding operations, during shipping, and intensive breeding practices.

Understanding behavioural markers of reptile and amphibian welfare, coupled with mounting evidence detailing the behavioral repercussions of substandard husbandry practices, is rapidly advancing.[19, 34] While ensuring positive welfare and a 'life worth living' for companion animals is now a prevailing objective, indications suggest that most reptile owners are grappling with challenges to ensure even the survival of their pets.[40, 41, 42]

When evaluating the appropriateness of maintaining reptiles and amphibians in captivity, many elements necessitate consideration. This encompasses the fact that numerous reptile and amphibian

species possess specialized adaptations to various aspects of their natural habitats, rendering them susceptible to challenges when adapting to artificial conditions.[14] The ramifications of inadequate adjustment to captive settings are exacerbated by the complexity of evaluating reptile well-being beyond rudimentary parameters, even by skilled caretakers and veterinarians.[43, 44]

Conventional viewpoints among caretakers often involve oversimplified criteria such as the mere presence of movement and feeding, or the outward appearance of health, growth, and reproduction, disregarding deeper welfare aspects. These prevailing attitudes and societal norms greatly undermine delivering optimal welfare standards for captive reptiles and amphibians. Such welfare issues can manifest conspicuously or covertly, leading to abnormal behaviors, unwarranted stress and concealed ailments, obvious illnesses, and eventual mortality.

Additionally, factors tied to the handling, housing, maintenance, and transit practices associated with obtaining reptiles and amphibians from the wild or through captive breeding deserve heightened scrutiny, as they exert substantial influence on reptilian and amphibian life trajectories. Green Iguana with no climbing activity lose muscle strength, contributing to egg-laying problems. Ball pythons reared in rack (drawer) systems that deprive them of stimulation are slower learners than when kept in complicated and stimulating environments. Beyond well-being concerns, retaining reptiles and amphibians in captivity also gives rise to challenges to species conservation, ecological perturbation, the potential diffusion of exotic diseases to native animals, and the risk of zoonotic disease transmission.

But is reptile and amphibian welfare just a matter of enhancing husbandry practices and treating illness and disease? Do we – can we – provide a life that delivers what reptiles and amphibians need, beyond survival and to an elevated level of thriving?

Reptiles and amphibians can be kept alive, and even breed in captivity – but those measures should not equate with thriving or the exhibition of natural behaviours. They are ultimately a deficient way to judge a reptile or amphibian's quality of life. Captivity introduces discomfort, fear, and distress, and does not allow for the expression of normal behaviours. Consequently, owners are destined to also fail to meet the Five Freedoms[1] as these animals' live experience intensely limited lives.[45] Even the best care guides and enrichments will not raise this failure to a passing evaluation.

[1] Freedom from hunger and thirst; Freedom from pain, injury and disease; Freedom from distress; Freedom from discomfort; Freedom to express behaviours that promote well-being.

Photo: A bearded dragon confiscated from the exotic pet trade.
Credit: World Animal Protection / Noelly Castro

Introduction

How do purchasers of reptile and amphibian pets obtain knowledge about the animal of their interest? This information may be provided by a family member or friend; shopkeeper; store staff; a breeder at an expo table selling their own animals; a veterinarian; or from the internet. Would-be reptile and amphibian pet owners often begin their education with a "care guide" – husbandry-focused information detailing the environmental and behavioral needs of the animal they wish to have. Reptile and amphibian care guides (usually printed) run the gamut from disarmingly simple and incorrect to advanced and exhaustive. Interestingly, care guides do not typically include facts about the legality of the animal nor its potential to deliver a zoonotic disease, data that may influence purchase decisions.[46] While simpler and shorter care guides may be perceived as achievable by a potential owner, the lack of thorough and accurate information may set an owner up for failure and doom an animal to neglect, suffering, and death.

In this analysis, PetSmart's care guides were reviewed for accuracy and completeness of husbandry information including recommended habitat size, lighting, temperature, advice for delivering hydration to the species, and diet, in addition to stated behavioral traits, adult size, and life expectancy. The specified suitability of a particular species for an owner was evaluated as well as any natural history about the species in question (if provided). Species reviewed include reptiles and amphibians commonly found in the exotic pet trade:

- Ball Python, *Python regius*
- Corn Snake, *Pantherophis guttatus**
- Bearded Dragon, *Pogona vitticeps*
- Veiled Chameleon, *Chamaeleo calyptratus**
- Leopard Gecko, *Eublepharis macularius*
- Bahaman Anole, *Anolis sagrei**
- Hermann's Tortoise, *Testudo hermanni**
- Russian Tortoise, *Testudo horsfieldii**
- Greek Tortoise, *Testudo graeca**
- African Sideneck Turtle, *Pelusios castaneus**
- African Helmeted Turtle, *Pelomedusa subrufa**
- Red-eared Slider, *Trachemys scripta elegans**
- African Dwarf Frog, *Hymenochirus* spp.*
- Horned Frog, *Ceratophrys cranwelli*

A detailed review of each species can be found in Appendix I.

Care guide analysis and animal welfare issues

A majority of reptiles and amphibians in this list lack a care guide specific to the species as denoted by an asterisk *. In the case of Jackson's and Veiled Chameleons, they were combined in a single care guide; likewise, Hermann's, Greek, and Russian Tortoises are combined. The care guide for Anole lizard does not denote any particular species, although the photograph used is of a Green Anole (Anolis carolinensis). All aquatic turtle species are relegated to a single care guide.

Overall, the guides lack information that may be useful to owners, from the Latin binomial species name to research the animal, to natural history, to the type of equipment needed, its purpose, and use to the animal. Every care guide included potential signs of illness and disease – but does not include useful references or photographs against which "increased shedding" or "discolored skin" could be compared. When reviewing the multiple guides for tortoise care, within one guide, two different temperature regimes were given for the same species.

How (or if) water should be provided to different animal species, and for what purposes, is often vague. Corn Snakes and Ball Pythons need a "big water dish," yet there is no information on how large (fit entire body?) or how deep. There is no recommendation for drinking water for Bearded Dragons, perpetuating a myth that semi-arid species do not need water. Veiled Chameleon water recommendation provides more information but lacks specific details. For example, when should water be delivered to Veiled Chameleons? How much volume per hour or per day? Is a fogger the same as a dripper and a mister in terms of its usefulness for the animal? Temperatures for Veiled Chameleons are incorrect; they seem possibly sourced from weather information versus the actual microclimate in which the animals are found during their birth and growth period. Tortoises need a "water dish," but no description is provided on the size or depth. A would-be tortoise owner might purchase a small dog bowl, or small reptile "rock" bowl that would be far too small for these tortoise species to immerse their whole body, stretch their neck, and drink.

Some guides caution against habitats receiving sunlight (creating difficulty in controlling temperatures) while others suggest UVB light is needed only if the habitat does not receive enough sunlight. It is well known that UVB rays are blocked by plastic and glass; sunlight through plastic and glass does not provide UVB exposure to animals.[47]

If a prospective owner used these guides to compare and contrast care requirements, it would be a difficult task as the guides themselves are not consistent in their format, location of information, or language. In PetSmart's care guides, dietary terms are inconsistent; some animals are "vegetarians" (a term used to indicate a human diet choice) instead of herbivores. Correct supplies are touted as the means to "help your reptile live their best life." Owners can keep their pet's "tummies happy". Animals are often described as "loving" a basking area, "love" to climb, "go crazy" for live insects, "love" vegetables or other emotive language that obscures their actual needs. Beyond evoking any emotional response in a reptile and amphibian, these behaviours have more important functions for health and survival, in the wild and captivity.

Basking is necessary for ectotherms to regulate their body temperature and all physiological systems (digestion, immune system, cardiovascular system, circadian rhythm). Exposure to UVB is essential in the skin synthesis of vitamin D3, the skin's immune system, and may also stimulate production of "feel good" beta endorphins.[47] Climbing may be how a lizard secures a vantage point for hunting, and to monitor conspecifics and potential predators – and is likely behaviorally "hard-wired" in the species – a habitat without climbing opportunities for such animals may induce stress and frustration. Insectivores displaying hunting behaviour may demonstrate increased focus and activity when offered live food. Herbivores and omnivores eat plant material and recognize such offerings as food. Further, "loving" certain food items does not indicate its healthfulness for an animal. Green Iguanas (Iguana iguana) will eat dry cat food if available – but it is hardly healthy for them. Dogs "love" table grapes, but their ingestion leads to acute renal failure.[48]

Listed below are the Five Freedoms[45] which outline aspects of animal welfare under human control. Considering these animal welfare objectives, it is potentially possible to ensure reptiles and amphibian kept as pets receive food, water, and medical attention if they are in distress, ill, or injured. However, it is likely impossible to safeguard reptiles and amphibians from discomfort; from fear and distress; and enable them to express normal behaviour.

1. freedom from hunger and thirst.
2. freedom from discomfort.
3. freedom from pain, injury or disease.
4. freedom to express normal behaviour.
5. freedom from fear and distress.

The foundational shortfall in meeting the Five Freedoms is the shockingly small habit size recommended for each species in PetSmart's care guides. The resulting severe confinement, as compared to the home range size of reptiles and amphibians in the wild, leaves the expression of "normal behaviour" as unachievable. For example, while PetSmart suggests that an owner of a tortoise should allow them to "wander between climates within its habitat by keeping one side of the terrarium warmer, with a high-watt heat bulb and a nice flat rock for basking, and the other side cooler," in no sense does a 50-gallon (by volume) habitat create different climates, nor does it provide space to roam. In comparison, the home range of a Hermann's Tortoise (Testudo hermanni) in Italy is 7.4 hectares for females and 4.6 hectares for males.[49] In Turkey, Hermann's Tortoises used between 0.08 to 12.36 hectares of space.[50]

To illustrate the loss of area, and using the above studies, 6.0 hectares was used as an average home range for a Hermann's Tortoise.[2] The 50-gallon habitat is only 0.0007% of an average 6-hectare home range area. This removes, at a minimum, more than 99.99% of the space a Hermann's Tortoise uses in the wild.

Bearded Dragons (*Pogona vitticeps*) average 2.9 hectares for their home range size[51] or 312,153 sq. ft. PetSmart recommends a 4 ft. x 2 ft. habitat (8 sq. ft.), claiming this is enough room for this lizard to "run and exercise." But again, the endorsed habitat area results in a loss of 99.99% of a Bearded Dragon's normal area.

This type of space reduction makes normal behaviour impossible. Severe confinement stymies normal behaviours. Wild Bearded Dragons movement patterns are driven to optimize preferred temperatures with large home-range sizes, yet wild Bearded Dragons lack site fidelity. In other words, Bearded Dragons move to control their body temperatures as would be expected by a lizard, they move frequently, and they use a great deal of space without returning to the same place each day. This is simply not possible in PetSmart's recommended 8 sq. ft. of space. Further, it should be noted that most animals do not exercise per se; rather, they are physically healthy as a consequence of the demands of foraging, evading predators, and finding mates.

Reptile and amphibian species exhibit sensory awareness across a broad spectrum of environmental variables, from apparent to subtle. The ability to recognize conspecifics, potential predators, vibratory communication, chemical cues, and dietary preferences, for instance, fundamentally relies on their capacity for ecosystem awareness.[52, 53, 54, 55, 56] This entails the comprehensive assessment of their habitat and the scrupulous monitoring of the presence and intentions of conspecifics, including humans, when these species find themselves in captivity.[57]

In the pet trade, no reptile or amphibian is considered to be domesticated, "adapted over time (as by selective breeding) from a wild or natural state to life in close association with and to the benefit of humans".[58] Transitioning from freedom to captivity can have profound physiological and psychological impacts on animals.[59] Reptiles and amphibians housed within artificial settings are exposed to a myriad of potential environmental stressors, which have the capacity to cause adverse effects on the welfare of captive organisms. These stressors encompass abiotic, non-living environmental elements, including artificial illumination, exposure to high-intensity or aversive auditory stimuli, arousing olfactory cues, and conditions characterized by uncomfortable temperatures

[2] For comparison: one hectare is equal to 2.47 acres. The size of a regulation U. S. National League football field is 1.32 acres. 6.0 hectares = 14.82 acres = 11.22 U. S. football fields or 646,272 square feet. A 50-gallon habitat, measuring 3 ft. x 1.5 ft., has an area of 4.5 sq. ft. or 0.0078% of a U. S. football field.

or unsuitable substrates. Furthermore, biotic stressors unique to captivity, such as constrictions on movement, limited access to retreat spaces, mandatory proximity to human presence, reduced opportunities for feeding, unconventional social or species groupings, and other impediments on the expression of natural behaviors, also exert negative effects on captive animals.

The extent and complexity of environmental cognition in reptiles and amphibians are profoundly influenced by inherent facets of their biological makeup. Innate physiological, psychological, and behavioral predispositions establish intrinsic expectations with a high degree of precision, aligning reptiles and amphibians for existence in their natural environment.[27, 57, 59, 60] Given their ingrained biological traits and acute perceptual abilities, it is reasonable to hypothesize that reptiles and amphibians, at a fundamental biological level, may perceive distinctions between their natural habitat and captivity, sensing a divergence from their anticipated ecological context. Reptiles and amphibians may be thought of as acutely aware of captivity.

Drive states are evolved motivational mechanisms designed to ensure that organisms take self-beneficial actions. The emergence of frustrated motivational states may potentially underlie psychological or behavioral maladaptation within captive settings. Regardless of the meticulous planning, spaciousness, and diversity of a captive setting, it arguably represents the most profound departure from the species' natural way of life, thereby posing significant challenges to their adaptive capacities.[57, 61, 62]

Enrichment can be defined as "the addition of environmental features, or changes in their method of presentation, which increase the complexity of a captive animal's environment, resulting in beneficial effects on behaviour and other aspects of biological functioning".[63] Enrichment is offered as means to mitigate the effects of captivity on reptiles and amphibians; however, it should been seen as necessary husbandry.[18, 20, 64, 65]

Enrichment for reptiles and amphibians may include greatly increased habitat space; variation in basking spots throughout a 24-hour cycle; variations in source, location and amount of water to stimulate natural behaviours; multiple areas of differing humidity levels offering reptiles and amphibians means to conserve water loss and assist in shedding skin; substrates can provoke differing activity levels; and habitat décor can provide a reptile or amphibian the means to exhibit climbing, basking, hiding, mating, chemosensory investigation, and other natural behaviours.

Currently, enrichment is without standardized assessment tools, or even a clear definition: "For instance, does it constitute enrichment to provide an arboreal species that has been kept terrestrially its entire life with a tree branch for climbing, or a fossorial species with deep natural substrate for burrowing, or a heliothermic species with a basking spot for thermoregulation?".[20] Enrichment builds on the paucity of captive environments – yet it is not a remedy for the deprivation of captivity. Captive environments will always fall short when compared to the complexity and variation of nature.

Spatial considerations for snakes

An often-overlooked captivity-related welfare issue is the exceedingly small habitats in which reptiles live. Most caging is spatially deficient, which forces an active reptile to engage in an unnatural lack of movement, or, particularly in the case of snakes, unnatural postures.[84, 85]

The occurrence of rectilinear behavior among snakes, characterized by the adoption of a straight or nearly straight posture known as "stretching out," is a widely recognized, distinctive, and inherent facet of snake biology, apparent during both the execution of locomotion (movement) and phases of rest.[86] As an illustration, an investigation delving into rectilinear behavior revealed that within the first hour of observation, 24 snakes (37%) from 14 species (45%) engaged in 'stretching out' behavior.[86] This study was conducted under diurnal (daytime) conditions, likely underestimating the occurrence of rectilinear behavior in snakes due to their normal nocturnal, crepuscular, or fossorial.

Many terrariums recommended in stores are exceptionally small. For example, PetSmart's Ball Python Care Guide (PetSmart, 2023) recommends a 40-gallon terrarium, measuring 91.44 cm X 45.72 cm X 43.18cm (36" X 18" X 17") which does not allow for rectilinear behavior in an adult snake of this species. With the suggested addition of two hides and a water bowl large enough to soak in, actual area to either rest flat or stretch out is either at a minimum or makes stretching out impossible. The lack of height also means that arboreal behaviours, which Ball Pythons engage in, are not possible.

Snakes kept in small and/or less stimulating enclosures–particularly those that do not permit complete extension–can exhibit heightened manifestations of stress when compared to their counterparts inhabiting larger, more enriched enclosures.[87] Certain snake species also demonstrate faster learning when housed in larger, more complicated habitats, and current research is also considering brain atrophy as a potential outcome of too-small enclosures.[88] Reduced space is a severe animal welfare problem given that the cognitive ability of snakes, particularly to spatial learning, is similar to or can exceed the capacity of avian and rodent species.[89]

Other often overlooked behavioural malady in reptiles include interactions with transparent terrarium boundaries ("glass surfing"), heightened or diminished activity levels, instances of aggression among co-occupants, augmented alertness, instances of head-concealment, and freezing behaviour.

Glass-surfing *(Michèle Hamers)*

Head concealment *(World Animal Protection / Aaron Gekoski)*

Top photo: Red footed tortoise with clear shell deformation which can be caused by an inappropriate environment and/or nutritional deficiencies

Bottom photo: Bearded dragons are very common in the pet industry but often suffer from health and welfare problems due to their captive environments

(Michèle Hamers / World Animal Protection)

Reptile welfare conclusions

Animal welfare is influenced by four key environmental factors:

- The degree to which the environment emulates the natural world.[78, 79]
- The level of environmental complexity (e.g., Bassett and Buchanan-Smith, 2007[80]).
- Opportunities for animals to exercise control and make choices (e.g., Boissy, et al. 2007[81]).
- The extent to which the environment caters to the specific needs of both the species and the individual (e.g., Kagan and Veasey, 2010[82]).

Enhancing animal welfare is closely linked to the successful execution of highly motivated, species-specific behaviors, as it bolsters coping abilities (e.g., Duncan, 1998[83]; Boissy, et al., 2007[81]).

Reptiles and amphibians need to actively engage with their environment for survival and reproduction. The concept of animal agency is the ability of animals to actively influence outcomes through adaptive, context-specific, and complex behaviors predicated on their sentience, individuality, lived experiences, cognition, sociality, and cultures.[66] Hence, agency is a central adaptive characteristic of animal life.[67]

The care guides provided by PetSmart, and captivity itself, ultimately deny reptiles and amphibians agency, through deprivation and severe confinement. Habitat size recommendations induce a substantial loss of autonomy, and within that space, there is little room for self-determination, choice, or any independence for a captive reptile or amphibian. Current reptile and amphibian husbandry may provide more and more choices, and opportunities for natural behaviour, but it cannot deliver even a small percentage of the area an animal uses in the wild – and with that theft of space, so too gone are the elements that would make "enrichment" superfluous.

Captivity-related health issues in reptiles and amphibians

Importation and shipment of reptiles often subjects them to inadequate conditions such as overcrowding causing unhygienic situations like animals defecating on each other. Reptiles and amphibians are also often kept in close quarters to conspecifics and other species and in poor conditions in pet stores, at reptile shows, in breeding operations, and at homes where they are kept as pets. The conditions in which animals are traded and kept contribute to the development and spread of diseases and infections.[36] Additionally, all reptiles and amphibian species can be at risk for various endo- and ectoparasites such as mites, ticks, and nematodes (e.g., Ellerd et al., 2022[68]).

In captivity, reptiles and amphibians are at risk to suffer from a range of illnesses (Table 1).

Photo: A bally python at a veterinary check-up. While very common in the pet industry, there are few veterinarians who are specialized in reptiles like the ball pythons.
(World Animal Protection / Aaron Gekoski)

Table 1. Incomplete overview of common health issues suffered by snakes and lizards.

Common health issues	Causes
Respiratory and mouth infections ("Mouth rot")	• Inadequate habitat • Inadequate temperature and/or humidity levels • Skin infections and/or shedding issues
Skin problems e.g., • Skin infections ("Scale rot") • Shedding issues • Thermal burns • Dermatitis	• Injuries from co-occupancy and/or live prey • Viruses, fungi, bacteria infections • Inappropriate humidity levels • Too cold environment • Poor nutrition • Poor overall health • Too close to heating source • Rostral abrasions from rubbing on cage surfaces
Obesity	• Inappropriate diet • Volume of provided food and/or frequency of provided food too great • Lack of natural movement
Reproductive diseases in females e.g., • Egg binding • Oviductal prolapse • Egg-yolk coelomitis	• Absence of appropriate egg-laying area • Muscle weakness • Dehydration • Poor overall health
Reproductive diseases in males e.g., • Hemipenal prolapse • Hemipenal trauma	• Poor overall health • Muscle weakness • Straining to defecate • Dehydration • Cancer
Ophidiomycosis ("Snake fungal disease")	• Fungal infection[3]
Constipation	• Limited access to water • Impaction from particulate substrate • Build-up exoskeletons from insects • Lack of movement
Muscle deterioration including osteoarthritis	• Lack of space • Lack of natural movement
Nutritional metabolic bone disease (NMBD)	• Deficiencies in dietary intake of calcium, Vitamin D3, and/or Vitamin D • Restricted exposure to UVB radiation • Suboptimal thermal conditions for basking
Chrysosporium anamorph of Nannizziopsis vriesii (CANV) ("Yellow fungus disease")	• Fungal infection[4]
Muscular Dystrophy (progressive weakness and loss of muscle mass)	• Improper breeding habits, e.g., inbreeding of species.[5]
Neurological disorders e.g., • Enigma Syndrome	• Inbreeding
Ranavirus	• Virus infection [6]
Cryptosporidiosis ("Crypto", a diarrheal disease)	• Caused by protozoan parasite Cryptosporidium spp and passed in the stool of an infected person or animal.[7]
Septicemic cutaneous ulcerative disease ("Shell rot")	• Bacteria or fungi entering through an abrasion • Poor animal husbandry.[8]

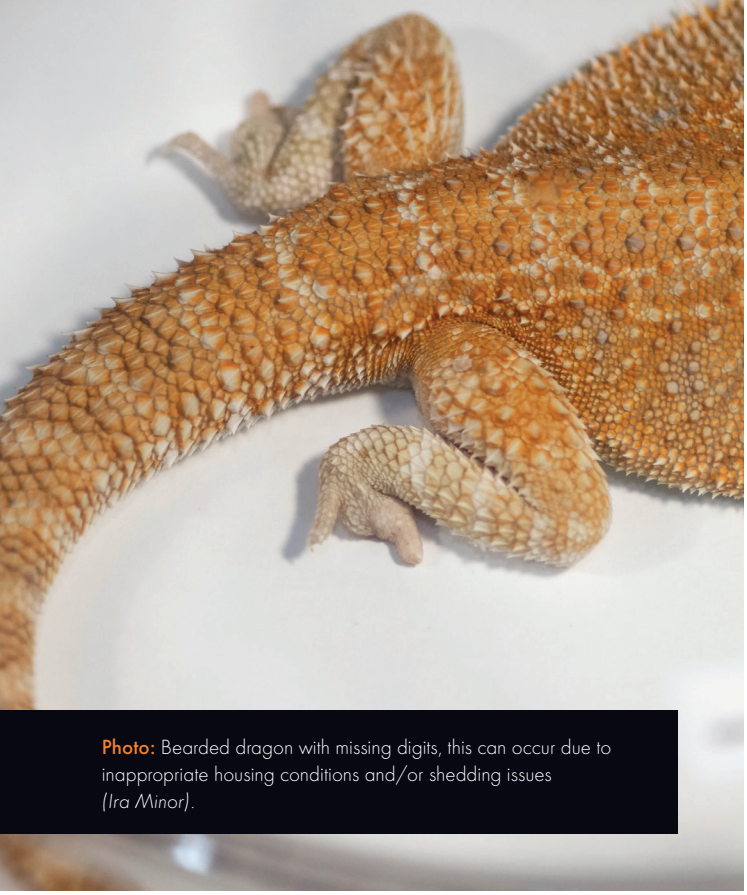

Photo: Bearded dragon with missing digits, this can occur due to inappropriate housing conditions and/or shedding issues *(Ira Minor)*.

The illnesses described above are common and the result of captive husbandry challenges and errors including but not limited to:

- Heating and lighting sources are placed where a captive animal can access them, causing burns.
- Live prey trying to defend itself from being eaten by reptile or amphibian.
- Transparent barriers and too-small habitats in which captive animal not understanding the see-through barrier attempts to get through the barrier repeatedly.
- Minor cuts, lacerations and bacterial and viral infections left untreated.
- Inappropriate social groupings resulting in aggression.
- Limited access to water, lack of movement, inappropriate substrates, or a build-up of exoskeletons from insects such as crickets causing constipation.

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[3] *Ophidiomyces ophiodiicola*, which has been affecting wild and captive snakes in North America, Europe, Asia, and Australia.[69, 70, 71] Ophidiomycosis leads to skin lesions, skin necrosis, and death.[72]

[4] Constitutes a fundamental fungal pathogen responsible for granulomatous dermatitis in reptiles including snakes, lizards, and crocodilians.[73, 74] CANV does not form part of the typical dermal microbiota in reptiles, and its potential to trigger affliction in healthy individuals has been documented.[73]

[5] Identified more than 60 years ago in amphibians and reptiles including Common Toad, American Bullfrog, European Tree Frog, Northern Crested Newt, Tiger Salamander, Green Anole, Green Iguana, Starred Agama, Algerian Uromastyx, Gold Tegu, Sand Lizard, Cape Dwarf Chameleon, Fischer's Chameleon, Balkan Whip Snake, Grass Snake, Central African Rock Python, Greek Tortoise, and European Pond Turtle.[75]

[6] In recent years, there has been a noticeable surge in documented instances of Ranavirus infections among reptilian populations. It is conceivable that the global trade encompassing reptiles and amphibians, in conjunction with the broad susceptibility range of Ranaviruses among diverse hosts, has served to amplify the emergence and dissemination of this infection. This phenomenon bears substantial implications for the well-being of both wild fauna and animals held within controlled settings.[76]

[7] Treated animals may remain carriers.

[8] Affects turtles and tortoises. The disease may progress to septicemia, causing the degradation of the liver and other organs.[77]

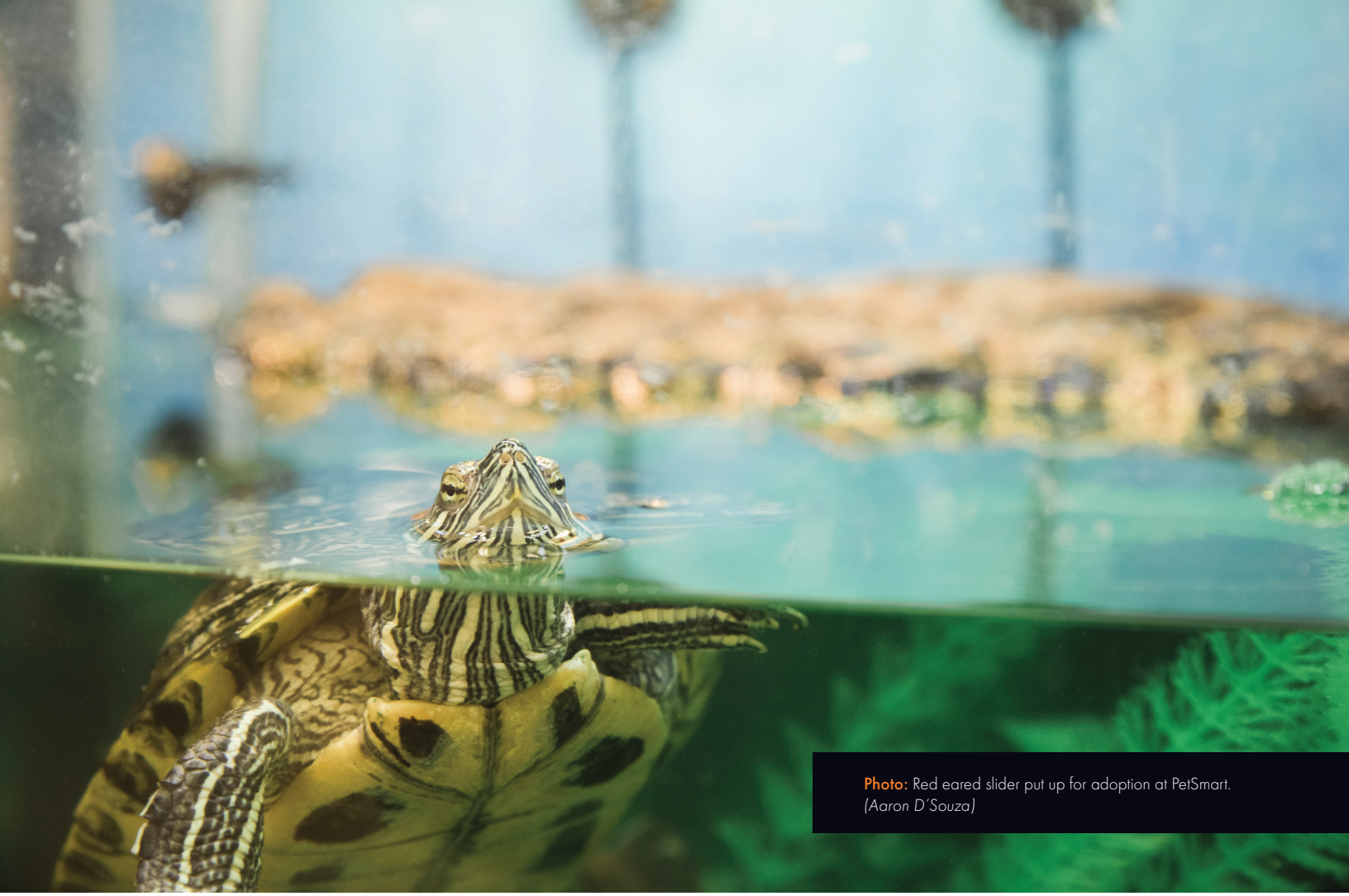

Photo: Red eared slider put up for adoption at PetSmart. *(Aaron D'Souza)*

Conclusion

The captive keeping of reptiles and amphibians as pets poses significant and unachievable challenges for the well-being of these animals. The transition from the wild to captivity has profoundly negative physiological and psychological impacts. The artificial settings they are housed in expose them to various stressors negatively affect their welfare. Despite efforts to provide enrichment, such as increased habitat space and variations in environmental features, captivity fundamentally restricts their natural behaviors.

The concept of animal agency, or the ability of animals to actively engage with their environment for survival and reproduction, is severely compromised in captivity. Standardized assessment tools for enrichment are lacking, and even the best care guides cannot begin to replicate the complexity and variation of nature. While reptiles and amphibians can survive in captivity, this should not be equated with thriving or exhibiting natural behaviors.

The inherent limitations of captivity, including discomfort, fear, distress, and often illness and disease, prevent these animals from expressing normal behaviors. Owners may struggle to meet the Five Freedoms, and even with the best care, captivity remains a deficient way to judge the quality of life for these creatures. Therefore, when considering the well-being and natural needs of reptiles and amphibians as sentient beings, it is not possible to recommend that they be kept in captivity. To do so is to establish and accept conditions of intolerable deprivation that neglects their true needs.

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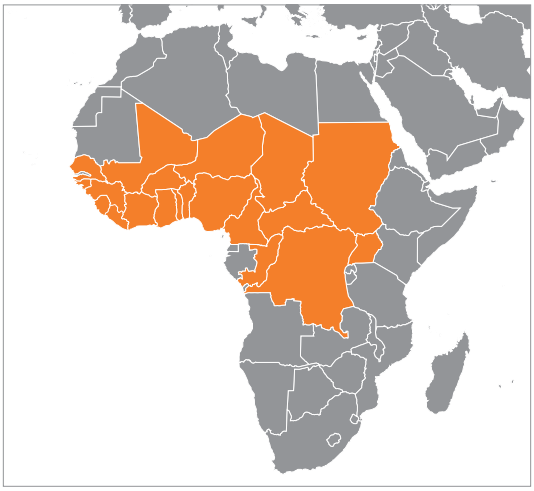
Appendix I: Review of reptile and amphibian species

Regular color morph *(Reptifiles.com)*



Range map

Ghanan python hunter
Image by Aaron Gekoski (courtesy, Mongabay, 2020)

REPTILES

Snakes

Ball Python *(Python regius)*

Description

The Ball Python naturally occurs in a variety of colors, spanning from black to albino, and exhibiting a deep dark brown with light brown blotches on its back and sides. Its underbelly, colored white, or cream is marked with black patterns dispersed throughout. This disruptive coloration is a form of camouflage in which high-contrast patterns break up an animal's outline.[90] Sporting a robust build, this snake features a relatively small head and smooth scales. Juvenile Ball Pythons measure less than 70 cm (28 in), but in its mature stage, they can grow up to a length of 182 cm (6 ft).[91] In the wild, their lifespan is approximately ten years, while in captivity they live up to forty years.

Wild habitats

Ball Pythons are indigenous to the western Sub-Saharan territories of Africa, including Senegal, Mali, Uganda, Guinea, Sierra Leone, and Nigeria.[92] Their habitat preferences encompass grasslands, savannas, and lightly wooded landscapes.[93, 94]

The Ball Python species thrives in both dry and humid environments.[95, 96, 97] Notably, this species cannot endure extreme arid conditions and appears to be absent from areas with less than 60 cm of annual rainfall.[98]

Conservation status

The Ball Python is listed as "Near Threatened" by the International Union for the Conservation of Nature (IUCN).[92]

This species, which is subjected to persistent poaching for various purposes including meat, leather, and traditional medicine, faces additional threats arising from habitat modification.[95] Foremost among the challenges, however, is the international exotic pet trade.[98, 99] The harvesting of individuals for the trade tends to target the most vulnerable life stages, particularly neonates and gravid females.[95, 100]

The recent surge in popularity of 'designer' color morphs within prominent import markets, notably North America and the European Union, was initially anticipated to alleviate stress on natural populations. Nevertheless, the Ball Python continues to be the most extensively traded live animal listed by CITES from Africa. Consequently, it appears that the introduction of designer morphs has not significantly augmented the sustainability of harvests. In fact, the persistent demand for novel genetic stock to facilitate the breeding of new color morphs could have further contributed to the strain on wild populations.[92]

Behavioural traits

The Ball Python exhibits primarily nocturnal or crepuscular behavior, becoming active during the periods of dusk, dawn, and nighttime.[101] Males tend to exhibit more semi-arboreal behaviors, while females lean towards terrestrial behaviors.[101] In their natural habitat, Ball Pythons demonstrate a preference for subterranean shelters such as mammal burrows, where they also undergo estivation, a period of dormancy during a hot or dry phase.[95]

Within their wild diet, Ball Pythons primarily consume small mammals and birds.[99] Juvenile Ball Pythons predominantly prey on small birds, whereas matured animals [exceeding 100 cm (39 in)] focus on small mammals as their primary food source. Among the species consumed, rodents constitute a significant portion of their diet, including Gambian pouched rats, black rats, rufous-nosed rats, shaggy rats, and striped grass mice. Prey preferences do manifest, with males showing a greater inclination towards birds and females favoring mammals.

Ball Pythons are renowned for their defensive strategy, characterized by coiling tightly into a protective ball when confronted, with the head and neck concealed within the central coils. While coiling into a "ball" is a normal response, this physical position should be interpreted as a signal that the animal is experiencing stress. This defense mechanism is commonly employed instead of aggressive defensive tendencies (i.e., biting), rendering the species easily manageable by humans, and contributing to its widespread popularity as a pet.[94]

Captivity-related health issues

A recent review of reptiles for sale at exotic pet shows in the US found more than 40% of tested animals had an endoparasitic infection.[68] An actinobacteria, *Actinomyces* sp., was found in more than 65% of breeding Ball Pythons in a large U.S. captive breeding operation, characterized by chronic inflammation of the oral cavity, cloaca, and hemipenes (phalli).[102]

In 2014, viruses falling under the *Nidovirales* order, *Tobaniviridae* family, and *Serpentovirinae* subfamily were initially identified as the underlying cause of pronounced respiratory disease in pythons.[103, 104] Subsequent investigations have confirmed the prevalence of these viruses as a significant contributor to diseases afflicting various snake species, with notable occurrences documented primarily among captive pythons within the confines of both the United States and Europe.[105]

Reptiles are themselves developing antibiotic-resistant bacterial infections, with Ball Pythons affected by *Citrobacter brakii*, *Delftia acidovorans*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Stenotrophomas maltophilia*.[106] While some Ball Pythons did respond to antibiotic treatment, those showing no clinical signs of improvement remained ill and are potential reservoirs of zoonotic pathogens to humans.

Captivity-related welfare issues

UV radiation has shown advantageous outcomes in reptiles.[107] Due to their crepuscular/nocturnal behaviours, UVA/UVB is rarely suggested as a husbandry practice for Ball Pythons. Nevertheless, UV exposure is likely beneficial to this species as they would be exposed to it during their activities at dusk and dawn, and thus should be provided.

Additionally, as crepuscular/nocturnal species, Ball Pythons likely experience disruptions in their normal activity cycle, when humans wish to interact with these crepuscular/nocturnal animals during the day.

Normal coloration of Corn Snakes *(Reptifiles.com)*

Corn Snake in the wild, Virginia *(srelherp.uga.edu)*

Range map of Corn Snakes

Corn Snake *(Pantherophis guttatus)*

Description

Upon attaining adulthood, the Corn Snake can achieve a total length, including its tail, from 61 to 182 cm (2.00 to 5.97 ft).[108] In its natural habitat, it lives between ten to fifteen years; within captive environments, it has the capacity to surpass 23 years.[109] The Corn Snake typically presents an appearance marked by an orange or brown body hue adorned with prominent red blotches demarcated by black outlines along its dorsal region. On its ventral side, distinct rows of alternating black and white markings are a noticeable feature. Despite its visual resemblance to the venomous Copperhead (*Agkistrodon contortrix*), the Corn Snake lacks venom, rendering it non-threatening.

Wild habitats

The Corn Snake maintains a presence across southeastern and central US regions, spanning from New Jersey to the Florida Keys. Its altitudinal range extends from sea level to an impressive 1,800 meters (6,000 feet).

Within its native habitats, the Corn Snake exhibits a marked preference for environments characterized by overgrown fields, clearings within forests, arboreal settings, palmetto flatwoods, as well as abandoned or scarcely frequented structures and agricultural plots. Notably, during the initial four months of its life, the Corn Snake primarily occupies terrestrial terrains, although it possesses the agility to ascend trees, cliffs, and elevated topographies.[110]

Conservation status

The Corn Snake is listed as a species of "least concern" by the IUCN.[111]

Behavioural traits

In regions characterized by cold climates, the Corn Snake enters a phase of brumation (a state or condition of sluggishness or inactivity) throughout the winter season. Within more temperate coastal regions, it seeks sanctuary within rock crevices and logs to endure periods of cold weather. Moreover, the snake exhibits an ability to seek refuge within confined spaces, such as the substructures of buildings, emerging on sunnier days to bask in solar heat.

Studies focused on the behavior and chemosensory capabilities of Corn Snakes indicate the paramount importance of smell in prey detection, with visual cues taking on a subordinate role.[112] This species employs a constriction technique to immobilize its small-sized prey effectively,[113, 114] and as with numerous members of the Colubridae family, Corn Snakes can showcase defensive tail vibration behaviour (shaking its tail, identical to a rattle snake), when feeling threatened.[115]

Captivity-related health issues

In a captive Colubrid breeding colony (Corn Snakes, King Snakes, Milk Snakes) where an outbreak of Proliferative strongyloidiasis occurred, fecal material from 63% of snakes housed in the affected facility was positive for nematodes and/or larvated ova.[116] Animals were exhibiting a range of symptoms including respiratory distress, facial deformation and declining body condition eventually resulting in death. The effectiveness of treatment against *Strongyloides* infection in snakes exhibits variability in outcomes.[117] Instances of full disease resolution accompanied by subsequent negative fecal examination findings are exceptionally infrequent.[118]

Cardiovascular disease has been reported in Corn Snakes.[119] Arteriosclerosis (damaged oxygen-carrying blood vessels) may manifest alongside diverse cardiovascular disorders, which are primarily attributed to the stress and impairment of arterial walls due to chronic high blood pressure, blood flow irregularities, or the response to endothelial inflammation or injury, including arteritis.[120, 121] The inception of arteritis (inflammation of the lining of arteries) can be traced to a spectrum of inflammatory ailments, with bacterial sepsis being a frequent causative factor.[122]

Captivity-related welfare issues

While Corn Snakes are considered diurnal, they may experience disruptions in their normal activity cycle, when humans expose them to lighting beyond their comfort. Corn Snakes are considered secretive and spend most of their daylight hours covered.[108] PetSmart's "The Most Popular Types of Pet Snakes," Corn Snakes are described as "great beginner snakes" as they "don't mind being handled". This does not take into account the normal hiding behavior of Corn Snakes and interactions may interrupt normal rest and sleep cycles, periods of activity, and interest in feeding.

Wild Bearded Dragon, *Pogona vitticeps* *(© Mitchell Hodgson)*

Bearded Dragon, Port Augusta, Australia *(© naughtyword)*

Range map

Lizards

Central Bearded Dragon *(Pogona vitticeps)*

Description

The Central Bearded Dragon, also referred to as the Inland Bearded Dragon, or just the Bearded Dragon, is member of the Agamid lizard family. Adults attain a body length of up to 60 cm (24 in), with the tail more than half of the entire body, bringing their total length up to 90 cm (36 in). Sexual dimorphism is observable; males are distinguishable by their broader cloacal aperture, expanded tail base, larger cranial dimensions, prominent beard, and the presence of hemipenes.[123] Additionally, males exhibit more pronounced femoral pores, visible as raised, waxy protuberances on the underside of their hind legs.

The Bearded Dragon exhibits a range of natural color variation, spanning tones of brown, reddish-brown, red, yellow, white, and orange. Its capacity for undergoing moderate shifts in coloration is exemplified by a row of slender spines along the neck, throat, and head, forming an evident pattern on each side of the body that extends towards the tail.

Their life expectancy in the wild is between 10 to 15 years, while in captivity they can live up to 20 years.

Habitat and current conditions

The Bearded Dragon is distributed across a wide spectrum of arid to semiarid landscapes in eastern and central Australia,[124] and can be found in a range of habitats from dry sclerophyll forests, eucalypt and Callitris woodlands, and mallee and acacia scrubs to sandplain and sand-ridge deserts.[125]

Conservation status

The Bearded Dragon is listed as a species of "least concern" by the International Union for the Conservation of Nature.[126] This species is known to be preyed on by introduced foxes and feral cats,[127] but they are thought to be no major threats to the species. Since 1960, Australia has banned the export of bearded dragons.

Behavioural traits

In the wild, adult Bearded Dragons' diet is 90% vegetable matter and 10% animal matter, while juveniles' diets are 50% vegetable matter and 50% animal matter.[128]

In the face of perceived threats, the Bearded Dragon responds by flattening its body against the ground, expanding its spiky throat, and extending its jaws to project a larger appearance. Bearded Dragons perform arm waving (circumduction) denoting submissive behavior, while dominant individuals will exhibit rapid head and body bobs.[129] Males typically present a darker 'beard' compared to females, and during courtship and mating, it often deepens to a nearly black shade. A darkened throat region or an overall darkened coloration across the entire body also appears when an individual feels stressed or ill.

Bearded Dragons use their limbs to lift the body entirely above the ground while in motion. This behavioral posture serves a dual purpose: minimizing heat absorption from the ground and augmenting the circulation of air over the ventral region, thereby contributing to an effective cooling mechanism.[130]

This species has a parietal eye (third eye), a photoreceptor found on the center of the head. This photoreceptor is responsible for thermoregulation and hormone regulation.

Stargazing in a Bearded Dragon caused by Atadenovirus
(Reptifiles.com)

"Soft bone" disease (i.e., metabolic bone disease) in a Bearded Dragon
(www.facebook.com/groups/1877923915847578)

Captivity-related health issues

In captivity, Bearded Dragons are often fed insects exclusively, resulting in gout and other nutritional-related diseases.[131] There is great importance in managing the diet of juveniles so that they recognize plant matter as food. There is an increased likelihood of nutritional disorders if Bearded Dragons are only offered insects and/or have learned to refuse to eat plant matter. Dried, pellet diets are suggested by stores, but these foods are not necessarily recognized by Bearded Dragons as diet items.

The dietary related condition of Nutritional Metabolic Bone Disease (NMBD) is most often encountered in juvenile Bearded Dragons. Clinical manifestations include anorexia, hypocalcemia, muscular debilitation, constipation, motor paralysis, tetany, skeletal malformations, and instances of pathological fractures.

The genus *Atadenovirus* is composed of a number of different virus species that infect specific types of reptiles. The adenovirus that infects Bearded Dragons (Agamid adenovirus 1), is widespread in captive populations in the US,[132, 133] and the most commonly identified virus in this species. This disease, also known as "stargazing," and "wasting disease," is highly contagious among Bearded Dragons, with young, old, and stressed animals being at greatest risk.

CANV or "yellow fungus disease," in Bearded Dragon is pronounced.[129] See Table 1 for more information.

In recent years, Bearded Dragon neuromuscular diseases, similar to muscular dystrophy in mammals, have been apparent in the pet trade, usually in young juveniles older than 6 months. It is described by inflexible joints, spastic muscle control, weak muscles, and individuals that flip themselves over instead of moving forward. Affected Bearded Dragons may have minor to severe symptoms and be unable to feed themselves.[135] A Facebook page is devoted to the affliction, thought to be caused by inbreeding.[9]

Neoplasia (cancers) is also reported in Bearded Dragons.[129]

[9] www.facebook.com/groups/1877923915847578

Bearded Dragon with injury from co-housed conspecific *(PETA)*

Bearded Dragon arm-waving *(BeardedDragon.org)*

Captivity-related welfare issues

Trauma-related injuries are common in neonate and juvenile Bearded Dragons, especially if housed in crowded conditions. Adult males are territorial and will injure other males when housed together. Further, Bearded Dragons may be cannibalistic, with larger animals attempting to consume smaller conspecifics.

As common in other reptile species, recommended terrariums are typically too small to create an adequate thermogradient, humidity gradient, or provide enough behavioural stimulation for this species, including allowing for fast movement or true climbing height. If pet store recommendations were taken at face value, the suggested habitat would be unstimulating and inadequate to keep muscles in good condition.

It is common that behaviours are misinterpreted by their owners or that incorrect information about behaviours is provided by pet stores or online. For example, arm-waving is described as "training," and as Bearded Dragons being "friendly" and may wave to communicate.[136] This statement suggests a waving Bearded Dragon may be saying hello, when in the wild it waves to communicate subordination to a dominate conspecific. There is no research supporting the idea that this behaviour is lizard-to-human communication.

Wild Veiled Chameleon, *Chamaeleo calyptratus*
(© nyinyi_aung_doelone)

Veiled Chameleon capturing prey insect *(a-z-animals.com)*

Range map

Veiled Chameleon *(Chamaeleo calyptratus)*

Description

The Veiled Chameleon is a member of the Chamaeleonidae family. During their neonate phase they exhibit a muted green coloration and lack the distinctive casques on their cranial region. As they advance in age, casques develop, accompanied by a progressive enhancement in color vibrancy and diversity.

Life span for this species is approximately 5 years in females and 8 years in males, and females are engaged in multiple reproductive cycles within a single year.

Wild habits

This chameleon species is native to Yemen and Saudi Arabia. Inhabiting the most densely vegetated expanse of the Arabian Peninsula, this arboreal species primarily thrives within woodland environments. Notably adaptable in its habitat selection, it frequents diverse niches including acacia branches, shrubbery, and cultivated plants.[137] Additionally, it spends time along tree-lined thoroughfares and within arboreal settings in village gardens.

Conservation status

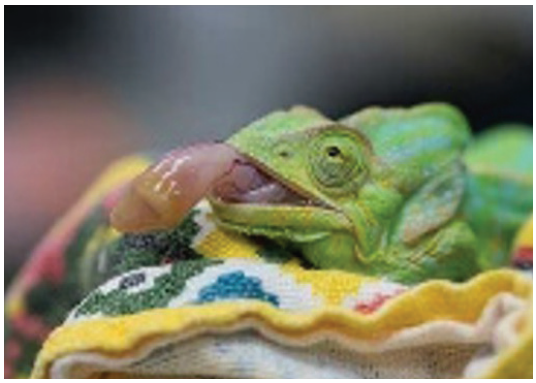
The Veiled Chameleon is listed as a species of "Least Concern" by IUCN.[138] While this species has historically been acquired for the pet trade, exports from the Arabian region have declined recently. The establishment of road networks and affiliated infrastructure could potentially pose site-specific challenges to the habitat of the chameleon, increasing the risk of road-related mortalities.[138]

Behavioural traits

The species is notably recognized for its remarkable color and pattern-changing ability, influenced by factors including aggression, communication of social status, facilitation of reproduction, and reactions to stressors. Both males and females also communicate by vibratory signaling (bio-tremors).[139, 140, 141]

Veiled Chameleons are diurnal lizards, active during the day. They are a specialized tree-climbing lizard that are masters in catching insects. Chameleon feet split at nearly a 180-degree angle allowing for a superior grip on the branches where they live. Another great climbing adaptation is the tail. Chameleons are some of the few lizards that have a fully prehensile tail, which can be used like a hand to hold onto objects and to help find and eat food while in the tree.

They have also developed ingenious attributes to allow them to hunt while staying relatively motionless. Veiled Chameleons can capture prey by extending its tongue, which is about 1.5 times the length of their body (excluding tail), at the speed of 26 body-lengths a second.[142] When the predators get ready to strike, they contract the muscles in their tongue, much as a person pulls back the string of a bow, also known as "elastic recoil".[143] The sticky and concave tip then captures the insect as the elasticity of the tongue pulls the prey into the mouth.



Chameleon with Metabolic Bone Disease
(Long Beach Animal Hospital)

Veiled Chameleon with CANV lesions
(chameleonacademy.com)

Captivity-related health issues

Captive Veiled Chameleons often suffer from metabolic bone disease (MBD) and nutritional secondary hyperparathyroidism caused by lack of UVB lighting and poor husbandry. This may lead to reduced calcification of bones, fractures, and muscle weakness, including the tongue.

Veiled Chameleon females do not require a male to develop eggs, hence females housed at warmer breeding temperatures may produce continuous egg clutches, and never recover from the metabolic demands of egg production and egg deposition, leading to eventual death. Frequently, stores don't provide information regarding egg laying – what a female Veiled Chameleon looks like as she is developing eggs, how her diet may change, or how and when to prepare an egg chamber. This leaves owners unprepared and may lead to the death of a female unable to lay her eggs.[144]

Like other reptiles, Veiled Chameleons are susceptible to CANV ("yellow fungus disease")[73, 74] Experimental exposure to CANV, whether on intact or damaged skin areas, infected more than 50% of Veiled Chameleons. Importantly, most affected lizards did not show visible signs of infection, and environmental testing of exposed culture plates on top of animal cages were tested but did not show growth of CANV until four weeks into the experiment. This suggests that CANV-infected individuals may be unwittingly passed from breeders to stores, and then to private individuals, potentially infecting other reptiles at each location.[145]

Captivity-related welfare issues

Trauma-related injuries are common in neonate and juvenile Veiled Chameleons, especially if housed in crowded conditions. Adult males are territorial and both males and females dislike interacting with conspecifics. Signs of stress include bright colors to warn away intruders; flattened body to look large and imposing; puffed-out gular (throat); gaping jaws; and/or front leg up in a protective position.

Veiled Chameleons need an extensive amount of climbing space that should be full of real and/or artificial plants to give the lizard numerus places to hide and adjust UVB exposure.[146]

As with other species, temperature and humidity recommendations are often problematic and inaccurate. In the wild, Veiled Chameleons are found in wadis (the bed or valley of a stream that is usually dry except during the rainy season) where temperature range from 22–25 °C (72–78 °F) in the daytime, and 13–18 °C (55–65 °F) at night [138]. They are also exposed to humidity ranges from 40–50% RH (daytime) and 80–100% RH (nighttime). Veiled Chameleons often suffer from dehydration because water is not offered in the correct manner (misting) or for too short a duration.

Veiled Chameleons do not tolerate handling. While rare individuals will climb on a human arm, they are better known for their intolerance of human interaction, even visual exchanges.[146] It is suggested in some care sheets to avoid handling for 3 to 4 days "while they adjust to their new home,".[147] Veiled Chameleon generally do not care to interact with humans, and handling is not recommended by experienced keepers as it may greatly induce stress and lead to illness in the species.[148]

Wild Leopard Gecko, *Eublepharis macularius*
(© Graham Armstrong)

Range map

Leopard Gecko *(Eublepharis macularius)*

Description

Leopard Geckos are small-sized lizards that can be distinguished by their spotted pattern as adults. Hatchlings are 7 to 10 cm (2.8 to 3.9 in) in length and weigh 2 to 5 grams. Fully grown females are 18 to 20 cm (7.1 to 7.9 in) and weigh from 50 to 70 grams. Adult male geckos measure between 20 to 28 cm (7.9 to 11.0 in) in length and weigh 60 to 80 grams.[149]

In the wild, it is thought that this species can live up to 8 years, in captivity it more than doubles, up to 20 years.

Wild habitats[10]

Leopard Geckos inhabit arid grasslands and deserts across the South-Asian territories of Afghanistan, Pakistan, north-west India, western Nepal, and certain parts of Iran.[150, 151] Leopard Geckos are found in arid and semi-arid conditions, characterized by modest vegetation and substrates composed of clay or sandy components, in addition to rocky terrains that offer protective crevices. Their range extends into arid forests, where they are known to seek refuge under the shelter of loose tree bark.[150] Leopard Geckos exhibit a distinct preference opposed to habitats dominated by sandy substrates.

The winter climate exposes them to notably cold temperatures, sometimes dipping below 10 °C (50 °F), prompting a semi-hibernation state known as brumation, during which the geckos rely on accumulated fat reserves for sustenance.

Conservation status

The Leopard Gecko is listed as a species of "Least Concern" by the IUCN.[152]

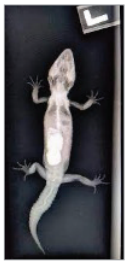
Behavioural traits

Leopard Geckos are generally terrestrial and classified as nocturnal.[153, 154, 155, 156] They retreat into burrows and concealed sheltered locations during the daytime, becoming active during twilight hours when temperatures are cooler.[150, 153 [11]] Some resources focused on the care of captive Leopard Geckos propose that these lizards exhibit crepuscular (appearing or active in twilight) or even cathemeral tendencies (activity pattern of irregular intervals during the day or night in which food is acquired).[157] This assertion has been put forth to explain the physiological capacity of captive Leopard Geckos to use UVB exposure for synthesizing vitamin D3 and to justify the provision of UVB lighting for captive Leopard Geckos.[158]

In contrast to many other gecko species, and like members of the Eublepharid family, Leopard Geckos lack adhesive lamellae on their toes. Consequently, they are not able to climb smooth vertical surfaces.[153]

[10] There are no field studies that have tracked Leopard Geckos in the wild.

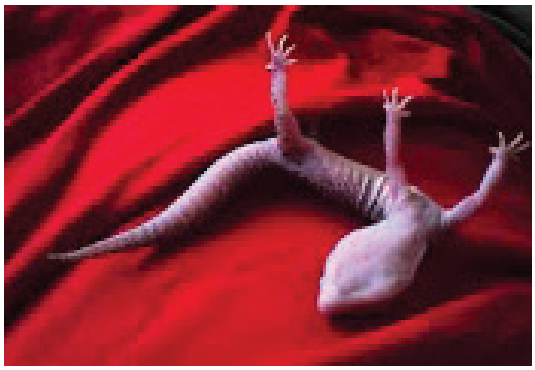
[11] This behaviour may have contributed to Leopard Geckos going unnoticed in Nepal until 2016 due to their nocturnal activity patterns.[150]



Right: Radiograph of Leopard Gecko with sand impaction *(www.facebook.com/exotvetnursetraining)*

Left: Cryptosporidiosis in Leopard Gecko *(Reptifiles.com)*

Mouth infection in Leopard Gecko
(Colorado Reptile Humane Society)



Enigma morph *(Reptifiles.com)*

Captivity-related health issues

In captivity, Leopard Geckos often suffer from intestinal impaction due to a combination of poor husbandry and ingesting inappropriate substrates (see Table 1).

Abrasive substrates such as sand may injure the ocular (eye) surface, and exudating infections may trap additional substrate, including around the mouth line. In a review of presented cases at a veterinary teaching hospital, 46% of Leopard Geckos had eye issues (i.e., ophthalmic disease).[159]

Shedding issues are also common in Leopard Geckos, especially if the animal has no access to a humidified chamber. Unshed skin may constrict toes and tail tip, leading to loss of nails, toe digits, and tail tip.[160] As with other reptiles, poor diets can result in gout as well as metabolic bone disease and nutritional secondary hyperparathyroidism.[161]

Cryptosporidiosis ("stick tail disease") is a wasting syndrome, causing rapid weight loss resulting in reduction of the fat reserves in the tail. This disease has been found in Leopard Gecko breeding colonies in the United States.[162] Euthanasia of positive individuals is recommended due to potential infection of other animals.

Enigma Syndrome is a late onset neuro-degenerative disease.[163, 164] This most commonly affects Leopard Gecko enigma morphs where the spots are in an irregular pattern, and which tend to look like speckles when the gecko is older. When they hatch, their dark areas tend to be blotches rather than bands. As they mature, the spotting increases and sometimes turns into speckles. Symptoms may include star gazing (head facing upward), head tilting, inability to catch prey, circling, death rolls, and seizures. Severely affected individuals may need to be assist-fed for the rest of their lives.

Captivity-related welfare issues

Available captive temperature recommendations are typically inappropriate. Leopard Geckos are semi-arid desert dwellers and experience dramatic temperatures differences between nighttime and daytime periods.[165] In the Salt Range in Punjab, Pakistan, daytime temperatures are between 32–38 °C (90–100 °F), while evening temperatures are 23–28 °C (73–82 °F). For this nocturnal species, their active period occurs with cooler temperatures, not those experienced during the heat of the day.[153] Without cooler temperatures, Leopard Geckos may not be active or hunt for prey to feed.

Leopard Gecko with metabolic bone disease
(Colorado Reptile Humane Society)

Stuck shed
(Colorado Reptile Humane Society)

Leopard Gecko with numerous layers of unshed skin around the eyes *(Colorado Reptile Humane Society)*

Bahaman Anole, Anolis sagrei
(wikipedia.org/wiki/en:Creative_Commons)

Range map

Bahaman Anole *(Anolis sagrei)*

Description

The Bahaman Anole (Anolis sagrei) typically presents as light brown with darker brown to black markings on its dorsal region, along with several lateral side lines ranging from tan to lighter hues. Similar to its counterparts within the Anole genus, this species possesses the ability to undergo color changes, shifting to a darker brown or black hue in response to external factors, such as temperature and humidity. It may also be influenced by hormonal changes and stress. The dewlap, a throat ornament, exhibits a color spectrum spanning from yellow to orange red.[166]

Bahaman Anoles range from approximately 17.8 to 20.3 cm (7.0 to 8.0 in), with certain specimens exceeding 22.9 cm (9.0 in). Females measure 7.6 to 15 cm (3.0 to 5.9 in). A distinguishing characteristic of the Bahaman Anole is the presence of a ridge extending from the tail up to the area behind the head.[166, 167] Female Bahaman Anoles possess heritable differences in dorsal patterning.[168]

The average lifespan of anoles in the wild is between 5 and 6 years, in captivity this can increase up to 8 years.

Wild habitats

The Bahaman Anole has an extremely wide range, having been introduced in much of the Caribbean (including Grenada), North America, Hawaii, and Taiwan.[169, 170] Because much of its introduced range lies close to its natural distribution centers, its native distribution is not entirely clear.[170]

Its habitat preference is open vegetation and areas characterized by moist forest cover. Bahaman Anoles thrive in a semi-tropical milieu, with a humidity range spanning from 40% to 80%. It prefers temperatures within the range of 23.8 °C–26.6 °C (75–80 °F), with a minimum temperature threshold of 18.3 °C (65 °F).

In Ecuador, home range size for Brown Anoles is approximately 16m^2 and is not affected by age class or season.[171] In the Bahamas, home range is smaller in adult females and young males in comparison to adult males.[172]

Conservation status

The Bahaman Anole is listed as a species of "Least Concern" by IUCN.[173]

Stress in Anolis lizard *(CoRHS)*

Behavioural traits

Bahaman Anoles are a terrestrial species categorized in "trunk-ground" ecological classification. Trunk-ground anoles are characterized by their tendency to perch on the lower trunk of trees or on rocks immediately under the tree trunk. They typically perch with their head facing downwards to locate any insects on the ground, and after spotting food, they jump down to capture it and then retreat up into the tree. A substantial portion of the diurnal period is spent foraging and basking.

They are opportunistic and will eat insects, grubs, mealworms, spiders, other lizards and their eggs, aquatic invertebrates, and fish, as well as their own molted skin and detached tails. They are also known to cannibalize their own hatchlings, as well as the hatchlings of Green Anoles.[166]

Bahaman Anoles establish territories with shrubbery, vines, fences, and arboreal structures.[174] During the breeding phase, males exhibit heightened territorial behaviors and employ their dewlap. This serves the dual purpose of repelling rival males and enticing prospective females.[175] This courtship display involves the male compacting his physique, unfurling his vibrant dewlap in a manner akin to a fan's expansion, and subsequently executing rhythmic head movements accompanied by distinctive "push-up" motions.

Captivity-related health issues

Similar to other reptile species, nutritional metabolic bone disease (NMBD) is a common disease in Bahaman Anoles. Clinical manifestations include anorexia, muscular debilitation, constipation, motor paralysis, tetany, skeletal malformations, and instances of pathological fractures. A central feature is inadequate skeletal mineralization and concurrent hypocalcemia (see Table 1).

Ranavirus was found in Bahaman Anoles imported from Florida, with skin lesions causing purulent to ulcerative-necrotizing dermatitis and eventual death.[76]

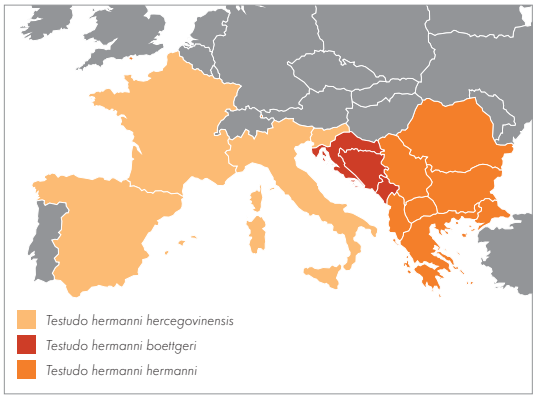
Captivity-related welfare issues

While individual Anole lizards may tolerate handling, they overwhelmingly prefer to not be touched. Even gentle handling may induce a stress reaction which can also lead to biting attempts. Rough handling can lead to tail loss. Bahaman Anoles are fast, can jump, and are not usually tolerant of handling, injuries can occur when they are trying to escape an owner. Subsequent injuries may occur during attempts to capture the animal.

Co-housing males is problematic with this species. They will fight which can lead to the non-feeding of one male as he hides to avoid conflict with a more dominant male. Co-housing males may also lead to trauma, injury, and death.[176]

Anoles obtain water by drinking from droplets; as such, their enclosures must be misted several times per day to ensure hydration. Standing water does not usually elicit a drinking response in this species. Dehydrated Anoles may experience related health problems. Mild dehydration can cause problems with blood pressure, heart rate, and maintaining body temperature. Severe dehydration can also cause muscle weakness and in extreme cases, it can lead to kidney damage, brain damage, and even death.

Wild Hermann's Tortoise, *Testudo hermanni*
(wikipedia.org/wiki/en:Creative_Commons)



Range map

Turtles

Mediterranean Tortoise *(Testudo spp.)*

The genus *Testudo*, encompassing Mediterranean Tortoises, is distributed across North Africa, Western Asia, and Europe. The classification and categorization of Testudo represent a challenging task within the scientific community.[177]

The following information is focused on the Russian Tortoise (*Testudo horsfieldii*), Greek Tortoise (*Testudo graeca*), and Hermann's Tortoise (*Testudo hermanni*). These tortoises are relatively small ranging from 7.0 to 35.0 cm (2.8 in to 13.8 in) and weigh from 0.7 to 7.0 kg (1.5 lbs. to 15.4 lbs.) and are popular pets.

Hermann's Tortoise *(Testudo hermanni)*

Description

Hermann's Tortoise has a highly arched shell with strong yellow or tan coloration and dark patches. The colors wash out somewhat in older animals, but the intense yellow is often maintained. The underside has two connected vertical dark bands that do not cross the central seam.

The lifespan is unknown but other species in the genus *Testudo* can live up to 120 years.

Wild habitats

Hermann's Tortoise is native to the southern regions of Europe, ranging from northeastern Spain to the southern reaches of France, Italy, Romania, and Turkey. They also have established populations on multiple Mediterranean islands, including the Balearics, Sardinia, Sicily, and Corsica. Its habitat preference is evergreen Mediterranean oak forests; a significant portion of this habitat has been lost to development and human occupation. As a consequence, Hermann's Tortoise now occupies arid ecosystems such as dry meadows, rocky inclines, arid hillside terrain, and cultivated fields.

This tortoise prefers locations that offer shade and sequestered resting spots, and typically avoids damp environs.[178] The home use area varies among distinct populations. Generally, females inhabit larger areas, ranging from 0.9 to 7.4 hectares (2.2 to 18.3 acres), with males possess territories spanning 0.7 to 4.6 hectares (1.7 to 11.4 acres).

Conservation status

The Hermann's Tortoise is listed as "Near Threatened" by the IUCN.[179]

Behavioural traits

During the winter period, Hermann's Tortoises undergo hibernation and reemerge into activity in the latter part of February. They display diurnal activity patterns. At dawn they leave their nocturnal refuges, characterized by recesses sheltered by hedgerows or dense shrubbery, in order to thermoregulate by exposing themselves to sunlight. Once warm, they traverse the meadows within their Mediterranean habitat, seeking food. Their sense of smell helps in selecting which plants to consume. They consume grasses, leaves, flowers and may also eat smaller insects and invertebrates when vegetation is scarce. Around midday, when the sun's intensity becomes excessive, they retreat to their refugia.[50] When circumstances dictate, they will enter prolonged states of dormancy throughout the summer months, especially during the hottest summer weeks when food is scarcer.

Hermann's Tortoises employ a diverse range of visual, auditory, tactile, and olfactory cues to communicate, and these same signals also play a role in the process of reproduction.[50]

Wild Greek Tortoise, *Testudo graeca*
(wikipedia.org/wiki/en:Creative_Commons)

Range map

Greek Tortoise *(Testudo graeca)*

Description

The Greek Tortoise, also called the Spur-thighed Tortoise, is characterized by its exceptional longevity, with a recorded lifespan exceeding 125 years and anecdotal accounts suggesting the possibility of attaining even 200 years.[180] They are similar to the Hermann's Tortoise but distinguishable by large symmetrical marking on their head, the spurs on each thigh, and different shell shape.

Wild habitats

The Greek Tortoise's range includes North Africa, Southern Europe, and Southwest Asia. It is prevalent in the Black Sea coast region of the Caucasus as well as in other regions of Georgia, Armenia, Iran, and Azerbaijan. They can survive in a wide range of habitats, including rocky hillsides, Mediterranean scrub, forests, fields, and meadows.

Conservation status

The Greek Tortoise is listed as "Vulnerable" by the IUCN.[181] Greek Tortoises are threatened by the pet trade and habitat degradation and loss.[181]

Behavioural traits

There are many subspecies of Greek Tortoises, representing different ecotypes.[182] Greek Tortoises living in colder climates hibernate at the cooler times of the year, while others do not hibernate given warm, year-round temperatures. These diurnal animals are terrestrial and occur in areas with low humidity and dry climates, retreating to burrows during the hotter times of the day. They begin their day by basking on rocks, their legs and head extended entirely. Then they graze, retiring afterwards to the closet burrow.[183, 184] Greek Tortoises are herbivorous and eat a variety of herbaceous grasses and plants across their range.

Wild Russian Tortoise, *Testudo horsfieldii*
(wikipedia.org/wiki/en:Creative_Commons)

Range map

Russian Tortoise *(Testudo horsfieldii)*

Description

The Russian Tortoise, also recognized under names such as the Afghan Tortoise, Central Asian Tortoise, and Horsfield's Tortoise,[185] is a small tortoise species, with a size range of 13 to 25 cm (5 to 10 in). Females grow slightly larger (15 to 25 cm [6 to 10 in]) to accommodate eggs. Males average 13 to 20 cm (5 to 8 in). The coloration of this species varies and can range from ruddy brown or black to yellow for the carapace (top shell) and brown to yellow for the body. Like other tortoises they can live for a long time, up to 50 years and sometimes even beyond that.

Wild habitats

This species is confined to Central Asia, spanning from the Caspian Sea, extending southward through Iran, Pakistan, and Afghanistan, and eastward across Kazakhstan into Xinjiang, China.[182] Russian Tortoises thrive in dry, open areas. They keep to sandy locations, where they can get around easily and burrow. Despite preferring arid environments primarily, Russian tortoises can survive well where humidity is 70 percent, and actually need some rain to soften the soil so they can dig their burrows.[186]

Conservation status

The Russian Tortoise is listed as "Vulnerable" by the IUCN.[187] Since the 1970s well over one million wild-caught adult Russian Tortoises have been imported into the US alone mostly for the pet trade. Probably less than one or two percent of these are alive today.[188]

The vulnerability of this species is significantly intensified by anthropogenic activities occurring within its native habitat.[187] Russian Tortoise populations are severely fragmented from each other, restricting gene flow. A continuing decline of breeding adults is reported.[189]

Behavioural traits

The Russian Tortoise has a particularly short period of activity, sometimes just three months per year. It comes out of hibernation in spring, usually in March, and actively forages and engages in mating until mid-June. Throughout much of its range, it will aestivate during the intense summer heat, coming out briefly at summer's end to feed before hibernation.[186] They are herbivores and eat a wide variety of plants materials.

These burrowers may dig as deep as 2 m (6–7 ft), where they retreat during the midday heat and at night, only emerging to forage at dawn or dusk when temperatures drop. The depth of its burrow also helps to insulate the tortoise from the cold of winter. These tortoises are quite social, and they will visit nearby burrows, and sometimes several individuals will spend the night in one burrow.[190, 191]

Russian Tortoises with Metabolic Bone Disease
(Chicago Exotics Animal Hospital)

Pyramiding in a tortoise *(Reptifiles.com)*

Captivity-related health and welfare issues

Captivity-related health issues – Greek, Russian, and Hermann's Tortoises

Upper Respiratory Tracts Diseases, *Mycoplasma spp.*, can cause disease in Russian, Greek, and Hermann's Tortoises. When ill, the tortoises typically stop feeding and thermoregulating normally. Symptoms include watery eyes and a liquid runny nose. The disease is highly infectious among groups of tortoises. If untreated it can lead to lung issues.

Ranaviruses can also affect these species and cause high mortality rates. There are no effective treatments and while animals may recover from signs of disease, they remain carriers.

Cryptosporidiosis (parasite infection) is also prevalent in Russian, Greek, and Hermann's Tortoises with no known treatment. Coccidiosis (gastrointestinal illness caused by a protozoan) is also found in Russian, Greek, and Hermann's Tortoises and treated animals can remain carriers.[192]

Russian, Greek, and Hermann's Tortoises in captivity are often fed an incorrect diet of vegetable and fruits instead of forbs and grasses, leading to nutritional deficiencies.[193] Tortoises require UVB; its absence or limited availability may lead to metabolic bone disease (MBD)/nutritional metabolic bone disease (NMBD).

Improper diet and humidity levels can also lead to shell pyramiding, a build-up of bone and keratin on the carapace scutes. Low humidity has been demonstrated to be a very significant factor in the development of pyramiding in Sulcata Tortoises and may have similar causes in other tortoise species.[194] Other contributors to the development of pyramiding include overfeeding; excess protein and/or fat in the diet; imbalance of calcium and phosphorus; limited exercise; and/or genetics. Environmental influences such as being kept outside the preferred operating temperatures, inadequate water intake, and lack of ultraviolet light may also contribute to pyramiding.[195]

Tortoises drinking *(www.youtube.com/@theearthminute4617)*

Captivity-related welfare issues – Greek, Russian, and Hermann's Tortoises

Given the large home ranges for all of these species, indoor habitats are typically a source of inadequate UVB, thermal gradients, humidity, area for movement, and induce stress through boredom. All tortoise species considered here may dig long and deep burrows to avoid the heat of the day, to provide themselves a humidity chamber, as well as to protect themselves from dropping temperatures at night. This is simply not possible in a domestic setting. Expert tortoise keepers strongly advise against keeping tortoise species indoors.[193]

At PetSmart, the guide that covers these three species does not adequately outline the differences in husbandry.[196] The tortoises also described as being able to "adopt to different environments," suggesting a flexibility that likely does not exist. It is true that these species have large natural ranges, and it is expected that local ecotypes are adapted for their particular climate and weather patterns. That does not mean, for example, that an adapted ecotype from a more arid region will do well in a more humid region, or vice versa.

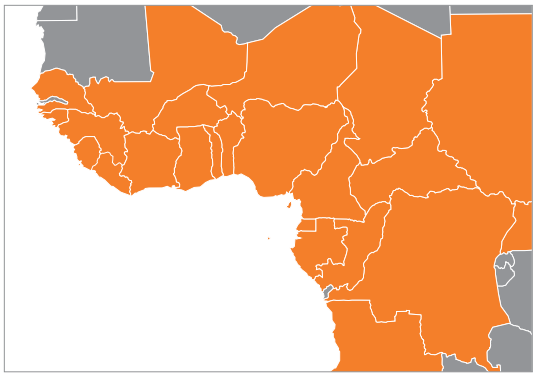
Hydration is important for all tortoises. Tortoises extend their necks to drink so a water dish must be shallow and accommodate the full body and extended neck length of the species in question.[191]

An herbivore is an animal anatomically and physiologically adapted to eating plant material, such as foliage, for the main component of its diet. Provided diet recommendations from PetSmart are inappropriate for all species. Fruit does not compose an even weekly portion of what these tortoises eat in the wild. They also do not eat "vegetables and greens," but rather, forbs and grasses that are higher in fiber and lower in available protein.[193]

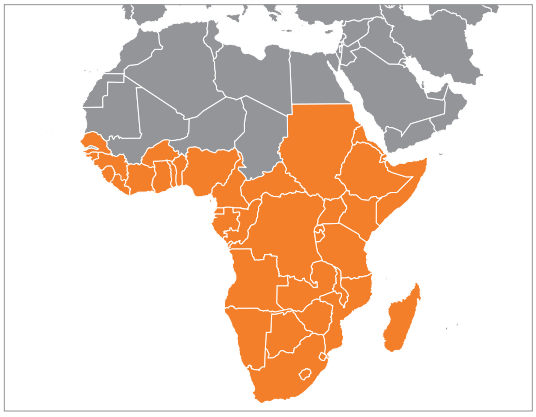
These tortoise species graze when it is cool outside, not during the heat of the day – and such grazing bouts may occur both in the morning and with the onset of afternoon shade. The recommendation to remove uneaten food after 4 hours ignores natural behaviour and may deprive a captive animal from consuming enough volume to maintain its health.

West African Mud Turtle *(Pelusios castaneus)*
(Pelomedusa.com)

African Helmeted Turtle *(Pelomedusa subrufa)*
(Pelomedusa.com)



Range map, West African Mud Turtle, *Pelusios castaneus*



African Helmeted Turtle *(Pelomedusa subrufa)*

African Aquatic Turtles
(Pelusios castaneus and Pelomedusa subrufa)

Description

Pelomedusidae is a family of freshwater turtles and range in size from 12 to 45 cm (4.7 to 17.7 in) in carapace length and are generally roundish in shape. They are unable to fully withdraw their heads into their shells, instead drawing them to the side and folding them beneath the upper edge of their shells, thus they are called side-necked turtles.[197] Like most turtle species, these turtles can live for a long time; more than 50 years in captivity.

The West African Mud Turtle, *Pelusios castaneus*, has a hinged plastron (bottom shell) that allows the plastron to be closed up against the carapace. This differentiates it from the African Helmeted Turtle (*Pelomedusa subrufa*) which sports a fixed plastron.

Wild habitats

This family of freshwater turtles are endemic to sub-Saharan Africa, including Madagascar, São Tomé, and the Seychelles.

The West African Mud Turtle is a freshwater species endemic to West and Central Africa and is found in Angola, Benin, Burkina Faso, Cameroon, Cape Verde, Democratic Republic of the Congo, Republic of the Congo, Equatorial Guinea, Gabon, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Príncipe, Senegal, Sierra Leone, and Togo.[185] Additionally, it has been introduced to Guadeloupe.[198] Their natural habitat consists of aquatic habitat like swamps, marshes, streams, and lagoons, surrounded by dense forest floors or submerged savannah.[199]

The African Helmeted Turtle, also known commonly as the marsh terrapin, the crocodile turtle, or in the pet trade as the African Side-necked Turtle, occurs in fresh and stagnant water bodies in much of Sub-Saharan Africa and in southern Yemen.[200] Its preference seems to be for standing water, such as swamps, pans, dams, and lakes. However, it is found to a lesser extent along rivers. It is generally absent from regions that are mountainous, forested, or desert.[201]

Conservation status

The African Sideneck Turtle and the West African Mud Turtle have not been assessed by the IUCN.

Behavioural traits

Pelomedusids turtles spend most of their time in the mud at the bottom of rivers or shallow lakes, where they eat invertebrates, such as insects, mollusks, and worms. The West African Mud Turtle is carnivorous and feeds on aquatic prey. Many species aestivate through the dry season, burying themselves in the mud.[197]

The African Sideneck Turtle is a semiaquatic omnivorous animal that feeds in the wild on insects, fish, tadpoles, snails, earthworms, vegetation, and carrion.

Basking preference varies by individual as well as the origin (if wild caught) as "Pelomedusa from tropical regions tend not to bask as much as those from subtropical regions".[202] African Sideneck Turtles are very shy baskers, and you may not catch them in the act.

Aquatic turtle with septicemia *(CoRHS)*

Captivity-related health issues

These species require UVB; its absence or limited availability may lead to metabolic bone disease (MBD)/nutritional metabolic bone disease (NMBD). African Side-necked Turtles, like other turtles and tortoises are also susceptible to "shell rot" (see Table 1).

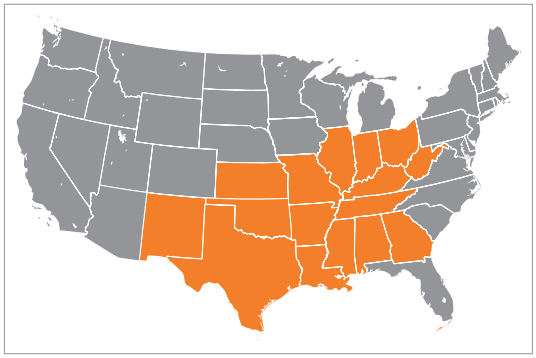
Aquatic Turtles often suffer from poor water quality and cleanliness. In captivity, aquatic turtles are eating and defecating in the same small body of water, hence proper filtration to maintain clean water is essential. Forced to swim, soak, and drink fouled water, an aquatic turtle may experience various bacterial infections and eventual septicemia.

If purchasing a 4" aquatic turtle (minimum legal sale size in the United States) and allowing for 10 gallons of water per "inch of turtle shell," you would purchase a 40-gallon aquarium. If following these guidelines, you would change out 20 gallons of water each week, completing a 100% water change each month. However, these water changes are unlikely to properly filter out all the food and fecal waste produced by a water turtle.

Captivity-related welfare issues

Aquatic turtles' needs vary depending on the conditions they face in the wild. PetSmart's guide, "How to Take Care of an Aquatic Turtle"[203] assumes incorrectly that all aquatic turtles have similar behavioural, water conditions and quality, and temperature needs. Size recommendations provided by pet stores for aquariums are too small and shallow to allow for normal behaviour.

Red-eared Slider, *Trachemys scripta elegans*
(www.beardsleyzoo.org/red-eared-slider.html)



Range map, Red-eared Slider, *Trachemys scripta elegans*

Red-eared Slider *(Trachemys scripta elegans)*

Description

The Red-eared Slider is an aquatic turtle in the Emydidae family and gets its name from the distinct red stripe above the ears and for rapidly sliding off surfaces like rocks and logs into aquatic habitats.[204]

The Red-eared Slider can attain lengths surpassing 40 cm (16 in), but this species typically exhibits lengths ranging from 15 to 20 cm (6 to 8 in). Females are larger in size than males. The lifespan of the Red-eared Slider generally spans between 20 and 30 years, with some instances of longevity exceeding 70 years.[182] Their lifespan tends to be curtailed when maintained in captivity.[205]

Wild habitats

Red-eared Sliders can be found in regions encompassing the Mississippi River and the Gulf of Mexico, specifically within the temperate climates of the Southeastern US. Their indigenous territories span from the northwestern parts of Oklahoma to Virginia and Florida. In their natural habitat, they tend to inhabit locales featuring still and warm water sources, including ponds, lakes, swamps, creeks, streams, and slowly flowing rivers. Within aquatic habitats, Red-eared Sliders gravitate toward tranquil waters, where their ability to access land is facilitated by surfaces like rocks or tree trunks, aiding their sunbathing routines for thermoregulation.

Conservation status

The Red-eared Slider has not been assessed by the IUCN.

Prevalent as a pet in the US and internationally, this turtle stands as the foremost choice among pet turtle keepers. Its invasive tendencies are prominent, rendering it the most invasive turtle species in the world.[206] Additionally, it holds the distinction of being the most widely traded turtle globally.[207]

Behavioural traits

These turtles often engage in communal sunbathing activities, with instances of individuals basking in groups. In their natural habitat, these turtles remain in proximity to water, except during specific circumstances such as searching for new habitats or instances when females venture onto land to deposit their eggs.[208] Their diet preferences are diverse, with aquatic vegetation constituting the primary food source for adults, although they exhibit omnivorous tendencies as well.

Courtship and reproduction in Red-eared Sliders are typically observed from March to July and unfold under water. Amid the courtship phase, the male engages in a circular swimming pattern around the female while producing fluttering or vibrating movements of his elongated claws, directed onto and around the female's facial and cranial regions. This action is possibly aimed at channeling pheromones towards the female. If responsive, the female advances towards the male, and if she displays receptiveness, she descends to the aquatic floor for the purpose of mating. However, if the female is unreceptive, she may become aggressive towards the male.[209]

Captivity-related health issues

Red-eared Sliders require UVB; its absence or limited availability may lead to Metabolic Bone Disease (MBD)/Nutritional Metabolic Bone Disease (NMBD). Like other turtles and tortoises, they are also susceptible to "shell rot" (see Table 1). Water quality and cleanliness is vital for these animals. When forced to swim, soak in, and drink fouled water, Red-eared Sliders may experience various bacterial infections and eventual septicemia.

Thiamine (Vitamin B1) is a water-soluble vitamin involved in energy metabolism.

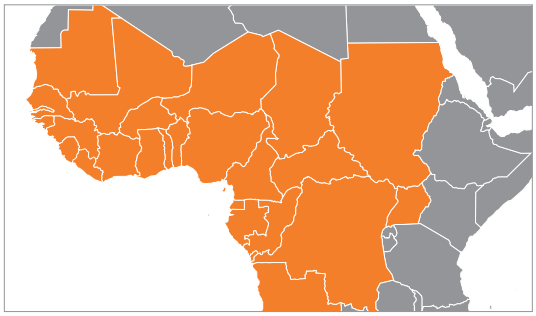
In captivity, Red-eared Sliders often experience Vitamin A deficiency; fungal infections; obesity; overgrown beaks and nails; aural infections; abscesses; prolapses of the phallus or cloaca; pyramiding; respiratory infections; obesity; and Vitamin B1 deficiency caused by the excess consumption of raw, thiaminase-containing fish and shellfish.[42, 203]

Captivity-related welfare issues

Red-eared Sliders have very long lifespans (~40 years), far beyond the interest of most owners. The animals themselves can be inexpensively acquired, while their need for superior filtration systems is conversely quite costly. This combination likely drives numerous inappropriate purchases, especially for children who are often attracted to these turtles. The low purchase price of the animal and the high cost of filtration systems often dooms this animal to a life in a too-small aquarium with dirty water. Without adequate filtration, frequent manual water changes are necessary, so the turtle does not live in foul water, and the tank does not produce malodorous scents in a home. Water maintenance is often stated as the reason an owner is surrendering their pet.

This species, like many other reptile species, are typically marketed as "great beginner pets" but in addition to the required space and complicated animal welfare and husbandry requirements, they do not necessarily want to interact with people. Aquatic turtles don't like to be handled, despite some stores claiming differently.[211] Except for encounters with predators, an aquatic turtle would never be in the air. This experience is likely both confusing and stressful.

African Dwarf Frog, *Hymenochirus* spp
(www.fishkeepingworld.com/african-dwarf-frog/)



Range map, African Dwarf Frog, *Hymenochirus* spp.

AMPHIBIANS

Frogs

African Dwarf Frog *(Hymenochirus spp.)*

Description

African Dwarf Frog comprises amphibians belonging to the *Hymenochirus* genus. Notably prevalent within the pet trade, they are frequently misidentified as the African Clawed Frog (Xenopus laevis), a visually similar frog species from the same family. They are distinguishable by the webbing on their front legs. African Dwarf Frog front toes are webbed, and African Clawed Frog front toes are not.

African Dwarf Frogs seldom exceed a few grams in weight. Their coloration displays range from olive green to brown, often adorned with characteristic black spots. The average life span is up to five years. These animals can attain a maximum length of 7.5 cm (3 inches).[212]

Wild habitats

These aquatic frogs are indigenous to Equatorial Africa. African Dwarf Frogs occur in Nigeria and Cameroon in the north, and south through Gabon, and east throughout the Congo River Basin.[213]

It is a water-dependent species, generally found in still, shaded water in lowland rainforest, and in pools by slow-flowing rivers. It is not known how adaptable it is to alteration of its habitat, but it can probably survive in secondary habitats providing that some form of canopy cover, or at least shade, remains.

Conservation status

Within *Hymenochirus* spp., *Hymenochirus boettgeri* and *Hymenochirus curtipes* are listed as a species of "Least Concern" by the IUCN. [214, 215] *Hymenochirus boulengeri* and *Hymenochirus feae* are considered "Data Deficient," and cannot be assessed.[216, 217]

Captivity-related health issues

Bacterial infections commonly affect African Dwarf Frogs, usually due to poor water quality in the tank. A bacterial infection is marked by cloudy eyes and redness or sores on the skin.[219]

In the case of frog "dropsy," the fluid that circulates in the lymphatic system fills the lymph nodes, does not drain properly, builds up outside of the normal tissues it usually stays in, and fills the abdominal cavity of the frog, thus causing edema (severe swelling). There is no known cause and treatment often involves manual aspiration of built-up fluids.[220]

Captivity-related welfare issues

African Dwarf Frogs' average life expectancy is around 5 years. Some can live longer but many die at an earlier age because they do not receive proper care including inadequate water maintenance, poor diet, being housed with aggressive fish, being housed in water that is too deep (they are weak swimmers), and lack of conspecifics as they are very social animals. African Dwarf Frogs are bottom feeders and need to be fed food items that sink; floating fish food will starve an African Dwarf Frog.

While water quality is extremely important for amphibian health, African Dwarf Frogs are very sensitive to vibrations in their habitats (in the wild, this assists them in finding prey). Aquarium currents created by filters that turtles tolerate may be detrimental to the health of this species.[221] Aquarium gravel should be large enough to avoid ingestion to prevent impaction.

Argentine Horned Frog, *Ceratophrys ornata*
(wikipedia.org/wiki/en:Creative_Commons)

Range map, Argentine Horned Frog, *Ceratophrys ornata*

Argentinean Horned Frog *(Ceratophrys ornate)*

Description

The Argentine Horned Frog (Ceratophrys ornata), also known in the pet industry as the Ornate Pacman frog, is a species in the family Ceratophryidae and is endemic to South America. It is the most common species of Horned Frog in the pet trade. This genus is known as 'Pacman' frogs due to their characteristic round shape and large mouth, suggestive of the video game character Pacman.[222]

The females can grow to be 16.5 cm (6.5 in) snout to vent and the males 11.5 cm (4.5 in). The average lifespan is 6 to 7 years; however, they can live up to 10 years or more in captivity.[222]

Wild habitats

This species can be found in the Pampean region of Argentina (Buenos Aires, Córdoba, Entre Ríos, LaPampa, Mendoza and Santa Fe), Uruguay (Rocha and San José), and Rio Grande do Sul, Brazil, from altitude 0 to 500 m. They live on the ground near temporary waterbodies and are also found in roadside ditches and in irrigated cropland.

Conservation status

Within Ceratophryidae, Argentinean Horned Frog, *Ceratophrys ornata* is listed as "Near Threatened" by the IUCN.[223] Habitat loss (due to agricultural development and housing development) is a major threat, as is water and soil pollution due to agriculture, industry, and human settlement. It is sometimes subject to killings because of unfounded beliefs that it is venomous.[224] It is also collected for the international pet trade and its eggs are sold internationally for scientific research.[225]

Behavioural traits

All horned frogs, hunt by remaining motionless, waiting for prey. They will try to eat anything that can fit in their mouths, and some things that can't, even if this leads to suffocation. In the wild, their typical diet would include rodents such as mice, small reptiles, as well as large spiders and insects such as locusts.[226] Their eggs are laid on the bottom of temporary ponds.[222]

Captivity-related health issues

Horned Frogs suffer from various diseases in captivity including metabolic bone disease (MBD)/nutritional metabolic bone disease (NMBD). This disorder is very common among captive reptiles and amphibians, causing soft bones and deformities in the skeletal system.

Alarmingly, the PetSmart care guide suggests that UVB lighting is not needed – but it is well known that both amphibians and reptiles suffer from metabolic bone disease (MBD)/nutritional secondary hyperparathyroidism (NSHT).[227] These recommendations can lead to difficulties in feeding and moving, illness, and death.

So-called "Toxic Out Syndrome," caused by foul, unclean water; edema syndrome; bacterial infections; fungal infections; endoparasites; blindness, possibly caused by a diet too high in fat; impaction; obesity; and respiratory diseases due to poor ventilation and mold build up are all common health issues in captive Horned Frogs.[228]

Captivity-related welfare issues

Horned Frogs spend most of their time burrowed in substrate. Terrariums do not allow for this natural behaviour. As burrowers, these animals need to feel secure in their environment; owners typically instead create a habitat in which the animal is easily seen, depriving a Horned Frog of feeling safe. In the wild, they are surrounded by plants, leaves, and other ground litter.

Because Horned Frogs are "ambush" predators and only move primarily to catch prey (besides courtship and mating movements in the wild), they may be prone to obesity in captivity when food availability is too great. As amphibians, they are sensitive to the oils on our skin, and other substances such as soap and disinfectants, and may be stressed by too much handling.

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