

LABORATORY HOUSING FOR REPTILES AND AMPHIBIANS

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There are over 6000 species of reptiles and 4000 species of amphibians. Some are completely aquatic, some rarely leave the trees, and some are burrowers. They are found in almost every habitat on the planet. At first glance, it would appear difficult to list criteria for laboratory housing such a diverse group of animals. There are also personality differences among individuals of the same species. One animal may be particularly aggressive towards the caretaker while another may be very docile. However, there are three general keys to successful housing: 1. ectothermy, 2. know the basic biology of the species and duplicate the most important features, and 3. caretakers must be able to recognize signs of stress and disease.

Reptiles and amphibians are ectotherms. Unlike birds and mammals, their body temperature is controlled by the environment. The optimal temperature for most behavioral and physiological functions varies. The advantage of ectothermy is that the resting metabolic rate and general energy requirements are less than for mammals or birds of comparable size. Metabolic energy is not spent on warming or cooling the body. Less energy is spent on searching for prey and feeding because less food is required to meet the body's energy demands. The disadvantage of ectothermy is that the ambient temperature controls the animal's metabolic processes and behavior. The animal must actively look for the temperatures that will allow it to feed, digest food, hibernate, etc. An animal selects its body temperature by finding the appropriate thermal environment through basking to absorb radiant or substrate heat, burrowing, hiding under logs or leaves, or entering water. For example, after a meal, snakes move towards a heat source to aid digestion and retreat to cooler areas following defecation.

In the wild, upper and lower thermal limits vary by species, geographic location, season, time of day, and reproductive status. Therefore, knowledge of the species' thermal limits is essential to proper housing. Microhabitat temperatures are also important. For example, although two lizard species may share the same desert habitat, the temperature range preferred

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by the species that lives on the surface can be different than that preferred by the burrower that lives in a cooler climate below.

Ectothermy

In captivity, if the reptile or amphibian spends all its time under or on the heat source, the ambient temperature is too cool. If it stays as far away as possible from the heat source, the temperature is too warm. Ectothermic needs are met by providing adequate light and temperature.

Amphibians tend to overheat easily. Most adults are nocturnal or spend most of their day under leaf litter. A single incandescent bulb provides a good basking site for frogs and toads.

Light and Temperature

In the laboratory, day length and general temperature can be set for the entire room. The temperature and day length should approximate that found in the animal's natural habitat. Day length (lighting) can be placed on a timer. Artificially controlled day length and temperature simulate natural daily cycles and seasons, which affect the animal's feeding behavior,



Figure 1: Lizard breeding enclosures in the off-exhibit area of the National Zoological Park's Reptile House in Washington, D.C. Broad-spectrum fluorescent and black light tubes are placed over the screened top of the enclosure. The heat lamp is provided on the side near the perches where the lizard basks. The plastic on the cage sides helps increase humidity. Photo by author.

reproductive cycle, and torpor. Jones (1978) gives a useful formula and presents tables for the average day length for any latitude on any week. If an investigator is working with nocturnal species, the light cycle could be reversed so that the animals are active during the investigator's day.

The quality of light is important for the general health of diurnal (active during the day) species. Sunlight, the best form of illumination is usually not available in reptile and amphibian facilities and, if available, the glass from windows and tanks blocks its beneficial ultraviolet (UV) rays. Animals that do not eat whole prey (such as herbivorous lizards) particularly rely on UV light to induce vitamin D₃ production which is necessary for calcium metabolism. UV light must therefore be provided artificially. In general, a long wavelength UV lamp (black light bulb) in combination with two or three broad-spectrum fluorescent tubes (i.e. "Vita Lite") is recommended for reptiles and larval amphibians such as tadpoles (Figure 1). Animals should not have direct access to the bulbs which, however, must be placed



Figure 2: Relative humidity can be measured in the enclosure. It should approximate the relative humidity found in the animal's microenvironment. Photo by author.

no more than four feet above them. No special lighting is required for nocturnal species although red, blue, or black lights can be used to illuminate the animal for the researcher.

Temperature can also be timer-controlled (evening temperatures drop significantly in the desert for example). The temperature gradient, however, must be controlled at the individual vivarium or tank level. The thermal gradient is essential in housing reptiles. Depending on the size of the enclosure, a gradient can be established by using either radiant heat from quartz heaters used to brood chicks, 25 to 250 watt incandescent light bulbs placed **outside** (Figure 1), or substrate heat such as heating pads, coils, or tapes placed **under** the enclosure. Air temperature for tropical species

should be maintained around 80° F (27° C) and for subtropical species at 68-77° F (20-25° C). A non-toxic stick-on thermometer can be placed inside the cage to monitor temperature. Cool retreats such as shelter boxes should be provided to prevent overheating. It is also important not to use solid-enclosure lids that prevent heat escape.

Hot rocks purchased from pet shops do not offer a thermal gradient. Their use inside enclosures force reptiles to choose between very cool substrate or a very hot basking site which can result in burns.

Humidity, Water, and Air

Different species have different needs in terms of relative humidity, water availability, and air flow. Humidity can be controlled at the room level if the animals are from the same habitat. Humidifiers can be used for this purpose. Generally, tropical species require require a relative humidity of at least 70%. Most species do well between 60% and 70% (Figure 2). Low humidity may result in poor shedding in reptiles and dessication in amphibians. In individual vivaria, humidity can be raised by placing the water source near the heat source.

Water serves many functions for reptiles and amphibians. For reptiles, it helps loosen skin about to be shed, helps body temperature regulation (thermoregulation), and is a drinking source. It is absolutely critical to amphibians. Although they do not drink, amphibians absorb water through the skin. They also breathe through membranes on the skin surface which must be kept moist. Since the skin is highly permeable to moisture and gases, amphibians become

overheated and dessicated easily if not provided a moist environment.

Amphibians reproduce, their eggs hatch, and their larvae grow in water or moist environments. Amphibians and reptiles benefit from daily water spraying with a plant mister. How much water to provide and its placement depends on the species. Some lizards do not drink from water bowls because they are biologically adapted to lapping water from the surface of leaves. Other animals such as snapping turtles and axolotls spend almost all of their time submerged. Snakes should be provided with fresh standing water from which to drink and, during periods of shedding, to submerge. Most terrestrial reptiles will drink from a small water bowl. It is important to provide any animal that enters the water with a grooved ramp or haul-out site to exit. Grooves or uneven surfaces on a ramp will allow clawed species like turtles to grip when they climb out of the water (Figure 3). Water can be separated from dry substrates by sealing a sheet of plexiglass into the tank as a partition.

Drinking and bathing water should be provided at room temperature. Some laboratories that house amphibians recommend water temperature for larval salamanders to be maintained at 10-12°C. Tadpoles should be kept in water at 18-22°C. The Canadian Council on Animal Care recommends that leopard frogs (*Rana pipiens*) be housed in large shallow-water tanks with flow-through water systems. The Council suggests a flow of 10-15 l/min in a 1m² tank for 50 frogs.

More so than reptiles, amphibians require dechlorinated water. All water must be kept



Figure 3: Basic amphibian holding tank at the National Zoological Park's Reptile House in Washington, D.C. The astroturf on the floor of the plastic bin slopes toward the bottom of the bin where water is pooled. The slope provides traction for frogs, salamanders, etc. Photo by author.

ANIMAL	LENGTH*	WIDTH	HEIGHT
Turtle	5x animal's length	3x animal's length	Must be escape-proof.
Crocodylian	5x animal's length	2x animal's length	Must be escape-proof.
Lizard	3x animal's length	2x animal's length	Arboreal and semi-aquatic: 2x animal's length. Terrestrial: between 1 and 8 feet.
Snake	3/4 animal's length	1/3 animal's length	Arboreal: 3/4 animal's length. Others: 1/2 animal's length or between 1 and 8 feet.
Small Amphibian	18 inches	10 inches	12 inches or 10 gallon tank.
Large Amphibian (Bullfrog)	30 inches	12 inches	12 inches or 15 gallon tank.

* Based on adult length.

Table 1: Suggested housing dimensions for individually housed reptiles and amphibians (from Demeter, 1989)

clean. Filtration and oxygenation or daily changes are critical for amphibians.

Escape-proof screens placed on the walls of the tank allow for air flow. Air flow should be one or two changes per hour.

The Enclosure or Tank

Many of the basic husbandry needs of reptiles and amphibians can be met with what, to human eyes, may seem like a stark and sterile enclosure. Hygienic cages or tanks in research facilities or off-exhibit areas at zoos have had major breeding and longevity successes. Plastic bins, aquarium tanks, polyurethaned wood and plexiglass enclosures work well for reptiles and amphibians. The size of the enclosure depends on the size and activity of the individual animal. Tank size must allow for a thermal gradient, room for exercise, cage furnishings, and establishment of territory if more than one animal is present (Table 1).

Many reptiles and amphibians use both vertical and horizontal space in their habitat. A small tank for tree-dwelling species with a complex, enriched vertical dimension that includes perches, foliage, etc. has more utilizable space than a larger tank which contains only horizontal space with little complexity.

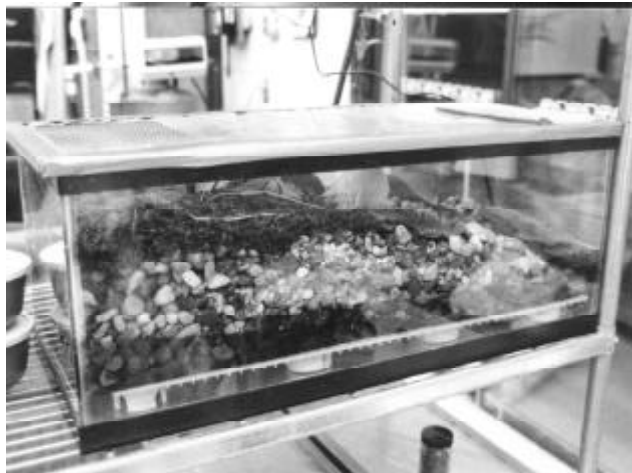


Figure 4: An off-exhibit breeding enclosure for small frogs at the National Zoological Park's Reptile House in Washington, D.C. This complex habitat contains moss, pebble, and leafy ground cover. Photo by author.

Furnishings can be simple washable plastic like PVC tubes. Materials that may leach chemical contaminants (e.g., dyes, fire retardants) must be avoided. Other design factors such as "haul-out" sites for turtles, rough objects for rubbing during ecdysis (shedding), and increasing the number and variety of basking or perching sites and retreats, allow the animals some control over their environments according to their preferences. Shredded newspaper makes ideal burrowing material for some species of reptiles. Leaf litter and potting soil are suitable substrates for amphibians and reptiles but must be changed frequently (Figure 4).

For ground substrate, newspaper is a highly recommended floor covering because it is clean, absorbent, inexpensive, and easy to change. Astroturf is often used because it is more aesthetic, is good rubbing material for shedding reptiles, and can be easily sanitized. To increase humidity, moss is a recommended substrate for small amphibians because it holds dampness well and provides cover. Moss and other organic material must be changed frequently to minimize bacterial and fungal growth. Other floorings like sand or wood shavings are not

suitable because they are often eaten by the animals and may cause digestive impaction. More aquatic species like newts, frogs, and salamanders do well with larger pebbles and gravel.

All cage props should be cleaned with a dilute bleach and water solution followed by rinsing with water.

Whether building a cage or using an aquarium to house the animals, seams should be tight and, for reptiles, latches should be placed on all doors and lids. Because the animals explore or attempt to escape, there should be no rough surfaces on cage walls or seams that can cause abrasions. Excitability and frustrated attempts to escape can also be reduced by eliminating the number of transparent sides on an enclosure. This is especially useful when new animals are introduced to an enclosure. Newly introduced frogs often jump into glass walls of the tank as if the barriers were invisible. By covering the outside of transparent walls with material such as opaque plastic or paint and providing appropriate retreats, the risk of physical trauma is reduced (Figure 5).

The animals must be able to hide from perceived predators such as cagemates or the human attendant. Hide-boxes or shelters and other tight-fitting retreats allow the animal to be completely contained as well as tactually aware of all sides of the interior. This provides psychological security through familiarity of the immediate environment (Figure 6).



Figure 5: The outside surface of three sides of these lizard tanks is painted dark green so that the animals cannot threaten each other between tanks. This is especially important in breeding facilities. National Zoological Park's Reptile House in Washington, D.C. Photo by author.

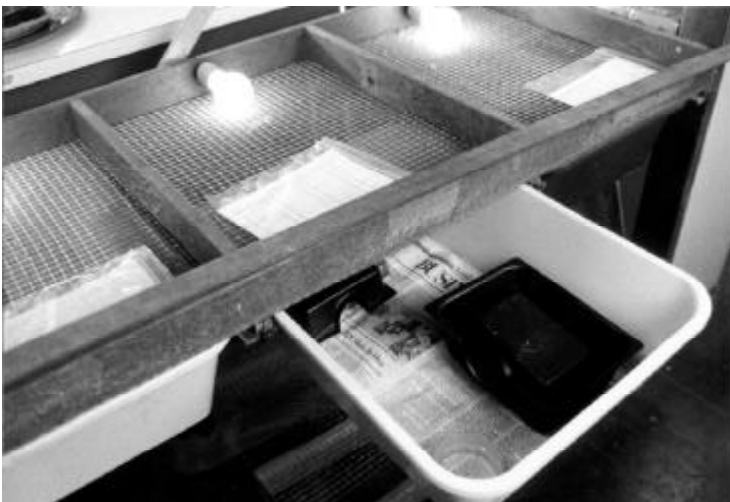


Figure 6: Simple enclosure for small reptiles. Two hide-boxes, fresh drinking water, and newspaper flooring are provided. National Zoological Park's Reptile House in Washington, D.C. Photo by author.

Olfactory cues are very important. Plethodontid salamanders, for example, mark their cage with pheromones excreted with the feces. Leaving a small amount of dry feces in the enclosure when cleaning rather than to disinfect the entire tank and

its props gives the animal home familiarity.

A brick or rock is useful as a rubbing surface at times of shedding.

Arboreal and semi-arboreal species require perches for escape, security, basking sites, and territory. Perch diameters, angles, and placement for basking and retreat depend on the individual animal's size and particular preferences. Perches should have diameters that will support the weight of the animal. The availability of perches is an important consideration when housing species who live in groups. Lizards, for example, who occupy the higher sites tend to be dominant, while those on lower sites are social subordinates.

Many reptiles and amphibians are territorial. Some individuals kept in the laboratory vivarium may suffer from being maintained in a social group, particularly if there is overcrowding. Utmost care must be taken that no overcrowding occurs, since it can lead to fighting, injury, and death. Territory and dominance are important in an enclosed system where resources such as basking sites and retreats are limited. Subordinate animals may become chronically stressed which may result in poor reproduction, feeding, and immune functions. Simple posturing of a dominant animal can suppress feeding of a subordinate animal in an adjacent tank.

There are also benefits to social housing if all individuals, including subordinates, are provided for in terms of thermoregulation, access to feed, and areas of seclusion independent of their relative standing in the social hierarchy. Placing animals together only when they would normally socialize, court, and mate in the wild has led to the breeding of species that were considered difficult to breed. Non-social species, however, should not be forced to live in social environments.

Handling

Handling of reptiles depends on the nature of the study. When routine handling is necessary (such as in order to clean the tank), the animal should become accustomed to this regular handling for several months before the start of an experiment. Frequent handling can be beneficial in that the animal may become more docile and tractable during minor procedures such as blood collection, transport, or veterinary inspection. There may be long-term reproductive costs, but that has yet to be experimentally shown. It is important to remember that each animal can respond differently to handling and that what works with one animal may not be good for another. Special care must be taken with venomous reptiles! Herpetological publications like *Vivarium* describe precautions.

Amphibians should be handled as little as possible. Tails of salamanders break off easily. Tail loss affects reproduction and dominance displays. Because all amphibians dry rapidly during handling, 5 to 10 ml of water should be provided in a cup periodically to keep them moist. Disturbances in the laboratory at the same time each day may delay metamorphosis and an abnormal fat accumulation in the developing hind legs of tadpoles. Therefore, an

irregular maintenance schedule for developing amphibians is recommended.

For most research purposes a simple, low-maintenance enclosure allows the animal to perform a wide range of normal behaviors, permits the researcher with easy capture of the animal, handling, fluid sampling if the animal is cannulated, and provides a low pathogen environment (Figures 3 and 6).

The above housing and handling recommendations are intended to meet the minimum conditions necessary to ensure survival and well-being of captive reptiles and amphibians in the laboratory setting. For more species-specific information, please refer to books by Frederick Frye or those produced by Advanced Vivarium Systems (P.O. Box 408, Lakeside, CA 92040) which provide a wealth of information on animal care, breeding, and disease. Many of these publications are geared towards the pet owner or the herpetoculturist and are equally useful to laboratory animal caretakers and researchers.

A Note on *Salmonella*

The Centers for Disease Control has determined that almost all, if not all, reptiles are carriers of *Salmonella* (Mermin, *et al.*, 1997). Incidence of salmonellosis related to contact with reptiles has increased in the United States paralleling the increase in households with reptile pets (particularly iguanas). Because *Salmonella* is only transferred to humans by ingestion, it is strongly recommended that anyone handling reptiles—or surfaces which reptiles may have touched—wash his or her hands immediately after contact. Ideally, washing facilities should be in or near the reptile housing facility. People who are immunocompromised (e.g., pregnant women, infants) are especially at risk.

Whether or not amphibians are carriers of *Salmonella* is unknown, but the same preventative handwashing is encouraged after handling.

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