ENVIRONMENTAL ENRICHMENT FOR AMPHIBIANS AND REPTILES

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ABSTRACT
Can reptiles and amphibia in captivity be enriched and does it enhance their wellbeing? Many would argue that enrichment efforts are better spend on other taxa and that good husbandry and a varied diet is all that is necessary. A flexibility of approach and an understanding of how the basic needs of reptiles, heat and light, food and water and substrate and furniture, can be manipulated to provide a more stimulating environment will be explored in this workshop. It will also provide practical experience in observation and implementation of such enrichment.

INTRODUCTION

The requirements of captive amphibians and reptiles will be reviewed in three areas:
1. physical characteristics of the captive environment.
2. contact with conspecifics
3. interaction with other species,

The opportunities for enrichment in different aspects of a captive environment, to improve the well being of these two groups will be reviewed.

1, PHYSICAL CHARACTERISTICS OF THE CAPTIVE ENVIRONMENT

- Space: enclosure size, the animals must not be restricted in movement, either basic locomotion or rapid movements. A too small enclosure affects the condition of reptiles causing overgrown claws and collision. Different taxa and species will have different minimum space requirements.
- Refuge is important. Some species only do well when they can be in contact with substrate on at least two or more sides.
- Spatial familiarity, the least recognised aspect of space. An enclosure very quickly becomes familiar to the occupants. Moving around furniture, waterbowls etc, causes more investigatory behaviour (like tongue flicking).
- Temperature: A fundamental feature of the captive environments for reptiles can be manipulated to increase welfare and activity.
    - Variation and gradients of temperature in an enclosure are important to provide choice; impossible if the space is too small.
    - Stationary substrate heating sources used alone have been criticised as potentially promoting unnatural behaviour because the continuous bottom heat will keep a location warm constantly, whereas the sun heat would move after a while.
    - Multiple substrate heating sources on timers that are switched on and off on a regular basis provide more variation.
    - Seasonal variation of temperature for hibernation can lead to an increase in breeding success.
    - Design of exhibits to use the seasonal varied angle of the sun.
    - Manipulation of incubation temperatures

- Light: another key variable that can interact with temperature in inducing selected behaviours. In outdoor enclosures captives experience light regimes relatively similar to the wild. For indoor enclosures captives are exposed to a light regime that may include some ambient light, often with selected wavelengths attenuated, as well as artificial light of selected wavelengths. Attempts on enrichment should focus on:-

- Daily and seasonal variation
- Long range UV light
- Taxon specific light quality and photoperiod needs.

- Water: critical aspect of the habitat for most amphibians and reptiles and a fundamental need for both taxa.
    - A diversity of water sources.
    - Water quality, water may need to be frequently changed because of need for aquatic feeding (any uneaten food will rot), aquatic defecation or urination and shedding of epidermal skin. This can result in a nitrogen induced toxemia.
    - The manner in which water is presented can be as important as the quality. Some species will lap of water droplets from vegetation and will never take water from a large source so water must be misted or sprayed on surfaces or vegetation.
    - life stages that live mostly or completely in water:
    - some species can detect prey only in water.
    - Olfactory: the use of chemical clues have the potential to alter behaviour in aquatic captives from foraging activities to social interactions through the use of selectively inoculated water sources.
    - Auditory: aqueous environments carry sound more effectively than terrestrial environments. Opportunities may exist to manipulate the social environment of captives that call underwater.

2. CONTACT WITH CONSPECIFICS.

Traditionally housing of single species and often, single specimens, rather than multi-animal or multi-species groups has been favoured because of the risk of injury or death from aggression or predation. Captive environments differ from those in the wild in that spatial constraints frequently increase population densities. In the wild, density is dependent on the social organisation of the species, which in herpetofauna varies from well defined territories (many lizards) to a total lack of any resource defence behaviour (many frogs).

Two different conditions of social grouping put captive amphibians and reptiles at high risk:

1) housing with aggressively territorial conspecifics
2) housing significantly different size classes together in the same enclosure.

Without opportunity to escape subordinate individuals in both categories risk immediate or protracted death. Cannibalism – may be a density dependent regulatory mechanism in the wild but may become an ethical question in captivity.

Keeping animals in high density in captivity can also result in:-

- Establishing of dominance hierarchies.
- Sub-optimal access to resources.
- Lack of breeding

Olfactory saturation can readily occur in small enclosures and can lead to saturation of odours in an enclosure which make it difficult to:-

- To pick up reproductive cues
- The olfactory avoidance of adults by juveniles

However keeping animals in isolation also poses problems:

In some species, some contact with con-specifics is important for species and kin recognition.

Especially important for animals in repatriation programs

3. INTERACTION WITH OTHER SPECIES. Active wild amphibians and reptiles are continuously exposed to a habitat of high complexity with diverse auditory, gustatory, olfactory, visual and perhaps other unrecognised stimuli from animals that share their habitat. There are many ways in which such stimuli might contribute to the well being of both groups.

Two key classes of interaction with other organisms:

PREY ORGANISMS FOR CAPTIVE HERPETOFAUNA:

- Lack of variety of live prey commercially available in captivity is an issue
- Often fed on a regular rather than an opportunistic schedule. Scheduling of feeding can be modified to increase variability.
- Use of insect attracting devices
- Olfactory tracking of prey. Novel enrichment that addresses the prey stimulating stimuli, requires knowledge of the sensory abilities of the species and can be as enriching as providing the prey itself.
- Use of alternative diets
- Prey recognition – particularly important for reptiles being repatriated.

Determining the most desirable form of enrichment requires experimental examination of the frequency and sequence of presentation.

Be aware of the hazards:

Living prey can pose risk to captive amphibians and reptiles. They can be injured, maimed, or even killed by the prey species/organism.

Ethical Considerations:

There are laws that govern what can be fed as live prey and it may be considered unacceptable to visitors.

PREDATOR EXPERIENCE FOR CAPTIVE HERPETOFAUNA:

Captive environments lack predators. However total isolation of predator associated stimuli can be a cause of lethargy and also cause stress.

There are numerous ways to provide stimuli that might be recognised as a predator:

- Adding faeces or shed skin of a predator or rubbing the extract of predators' scent on some spots.
- Using mobile shadow models that stimulate visually the presence of predator eg a bird of prey mobile
- Placing the predator in adjacent enclosure with either visual or olfactory access to the captive.

Predator recognition and developing an appropriate response is also particularly important for reptiles for repatriation.

DISCUSSION

That attempts to enrich captive amphibians and reptiles have been infrequent can probably be attributed to several factors.

– the fundamental differences that exist between amphibians and reptiles, their lower food requirements and lower activity levels, and the mammals have probably led to bias regarding their biological and behavioural needs. Stereotypies are unfrequently observed in amphibians and reptiles, the main type seen is glass climbing in lizards, but the problems of apathy and lethargy are common.

- amphibians and reptiles are far less familiar to humans than mammals and may be feared or disliked in the general population.
- the two groups have been rarely the focus of living zoological collections.

The enhanced welfare of individual animals resulting from enrichment not only translates into reduced veterinary care, but it can improve the way they are exhibited,

facilitate captive husbandry, enhance reproduction and improve public education and perception. Enrichment approaches centred on the perceived environment of the captive reptiles and this provides a basis for enhancing education about taxa less familiar to the public. Such educational approaches have a significant conservation value because they inform the public about the value of such animals.
Next, the possibility should always be considered that variation in behaviour may be important on an intra-specific, geographic, population and even individual level and this should promote species specific husbandry rather than the traditionally more simple taxon specific management techniques.
Approaches to enrichment should always be founded in the wild habits, abilities and sensory modalities of animals. There are still many areas which need to be researched, for example captive perception of the enclosure, exhibit design and ignored sensory capabilities or adequate socialisation.
The same principles of enrichment – Complexity, Choice and Change – should be routinely used to enhance the welfare of captive herpetofauna.

References:

Blake, E., Sherriff, D. and Skelton, T. (1998) Environmental Enrichment of Reptiles. ABWAK Guidelines for Environmental Enrichment. Editor: D.Field. p43.

Buley, K. (199?) What do baby snakes do in their spare time? Jersey Zoo Newsletter.

Burr, L. (1997) Reptile Enrichment: Scenting for response. Animal Keepers' Forum:24, p122

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Gibson, R. (199?) Happy Herps and Gecko Gallery, Jersey Zoo Newsletter

Hayes, M., Jennings, M., Mellen J. (1998) Beyond mammals: environmental enrichment for amphibians and reptiles. from Second Nature, Environmental Enrichment For Captive Animals, ed D.J. Shepherdson, J.D. Mellen, M. Hutchins, Smithsonian Institution Press, Chapter 13, pp205-235.

Kowalski, E. (1996) Skink enrichment. Animal Keepers' Forum: 23, p25.

Skelton, T. Can Reptiles be Enriched? (1996) Shape of Enrichment: 5#1, p3.

ENRICHMENT DEVICE LIST FOR REPTILES 2004

The following table has been compiled from the enrichment literature of enrichments used for reptiles in a variety of institutions. It is recommended that if trying something for the first time any risks are assessed and the reactions are monitored by observation. A full reference list is given at the end of the paper.

TYPE	ENRICHMENT	DESCRIPTION HOW USED	USED FOR:	REPORTED HAZARDS	REFERENCE
Food	Warm rodents	Warm, freshly killed, or warmed pre-frozen rodents can be moved about to simulate live prey. This may aid in the digestion of prey. Pythons and boas are encouraged to strike and 'kill' their food with great success at Edinburgh Zoo.	Snakes		Blake, E. et al. EE of reptiles. ABWAK EE Handbook Pp 43 –49
Food	Live insect scatter	Hand scattering of a variable quantity of crickets into a coarse substrate such as bark for foraging. For aquatic species locusts can be scattered on pond surface. Fruitflies provide less calories for more wore for small insectivorous lizards.	Insecivorous lizards, dwarf crocodiles.	Excess prey can injure reptiles	Blake, E. et al. EE of reptiles. ABWAK EE Handbook Pp 43 –49
Food	Insect attracting devices	Insect attracting light can be used to attract live insects into an exhibit . To be effective: 4. enclosures should not be insect proof 5. enclosures should be located in areas relatively rich in insects Alternatively the light can be set up away from the enclosure and the bag of insects released the next day.		Devices should not attract insects or other organisms that could harm the captives Devices should not create other conditions that are undesirable in	Hates et al Beyond mammals…. 2nd Nature

TYPE	ENRICHMENT	DESCRIPTION HOW USED	USED FOR:	REPORTED HAZARDS	REFERENCE
		An insect attracting plant could be placed in the enclosure.		the enclosure	
Food	Passive insect feeders	Passive insect feeders can be made from PVC pipe, screw top plastic jar, hollow log, length of bamboo, cleaned out gourds or coconuts. Hole/s of appropriate size for insects is drilled, the feeder filled and hung or placed in enclosure so insects emerge or drop at indefinite intervals	Insectivorous lizards, frogs, small crocodiles.	Excess insects can injure reptiles. Lizards learn to predict where the prey comes from and sit and wait in one position.	Hayes et al, Beyond mammals…2nd Nature
Sensory - Olfactory Food	Scent trails	A scent trail created by rubbing a dead mouse or piece of meat along the ground before hiding it under ark or a log The slime trail of live snails is followed by blue tongue lizards	Monitors Tiliqua – blue-tongue lizards	Creation of a feeding frenzy if more than one in exhibit.	Blake, E. et al. EE of reptiles. ABWAK EE Handbook Pp 43 –49
Food	Buried food	Bury prey item in a section of drainpipe filled with sand, leaves, gravel or small rocks. Excavation more difficult with heavier substrate	Monitors	Creation of a feeding frenzy if more than one in exhibit	Blake, E. et al. EE of reptiles. ABWAK EE Handbook Pp 43 –49
Food	Vegetation	A wide range of plants are used by herbivorous lizards, Living plants – Swiss cheese, Monstera sp., rubber plants and Ficus sp can be rotated through exhibit to give them time to grow new shoots. Branches with edible leaves – willow, lime, beech , mulberry, poplar, grape	Herbivorous lizards and tortoises		Blake, E. et al. EE of reptiles. ABWAK EE Handbook Pp 43 –49 Gibson, R. Happy Herps. Jersey Zoo Newsletter.

TYPE	ENRICHMENT	DESCRIPTION HOW USED	USED FOR:	REPORTED HAZARDS	REFERENCE
		forsythia, etc Hanging branches to make them hard to get to and process encourages fitness Large leaves can be skewered, on a wire ring. Weeds such as dandelions, groundsel, chickweed, nettle and wild garlic.			Kowalski, E. 1996 Animal Keepers Forum: 23, p 25
Food	Treats for tortoises	Cherry tomatoes Earthworms Parsnip Dandelion flowers	Tortoises		Spankler, S. Mill Mountain Zoo, Enrichment listserve - 2003
Food	Whole or large pieces of vegetable	Whole apples or corn floating on pond. Whole or large pieces of cabbage, corn, apples or carrots extend feeding time. Hanging the items a few centimeters off the ground on wooden or wire devices, provides an opportunity similar to foraging from shrubs,	Chelonians – herbivorous turtles, tortoises.		Blake, E. et al. EE of reptiles. ABWAK EE Handbook Pp 43 –49
Physical	Temperature gradient Temporal variation in temperature	Providing a temperature gradient provides choice. Additional spotlights on timers create different basking sites at different times of day. Lights can be manually moved several times a day. A drop of temperature at night	All reptiles		Blake, E. et al. EE of reptiles. ABWAK EE Handbook Pp 43 –49
Physical	Substrate	Provide each reptile with a substrate as close as possible to its natural	All reptiles	Leaf litter and naturally	Blake, E. et al. EE of reptiles. ABWAK EE

TYPE	ENRICHMENT	DESCRIPTION HOW USED	USED FOR:	REPORTED HAZARDS	REFERENCE
		substrate. Substrates used include organic potting mix, crushed leaves, pine shavings, shredded paper, peat moss, trimmed grass, dried bamboo leaves, Forest lizards should have deep bark, gravel or leaves, Such substrate can be raked to provide a different arrangement or flush out un-eaten insects.		collected substrates can sometimes carry mites,	Handbook Pp 43 –49 Trumby, J. Living Desert, CA; Brennan, L. Brandwine Zoo, DE Enrichment listserve 12/02
Physical	Mist with water	Misting with water can increase humidity and provide water to drink for some arboreal species.	Snakes Rainforest species. Frogs	Seasonal	Hayes et al. Beyond mammals:… 2nd Nature Wright, C. VA Zoo, Enrichment listserve-10/03
Physical	Large water bowls	Large water bowl big enough for full submersion	Snakes	Seasonal	Daily, A. Cincinati Zoo Enrichment listserve 2/04
Physical	UVB light	UVB lights on timers to simulate the moving sun are important to diurnal lizards.	Diurnal lizards originating from desert or arid regions	Exposure must be related to intensity animal would receive in natural habitat	Blake, E. et al. EE of reptiles. ABWAK EE Handbook Pp 43 –49
Physical	Enclosure furnishings	Branches for snakes and lizards to climb on can be suspended from the ceiling so there is some movement. Thick rope can be used to link branches.	Snakes and lizards		Blake, E. et al. EE of reptiles. ABWAK EE Handbook Pp 43 –49

TYPE	ENRICHMENT	DESCRIPTION HOW USED	USED FOR:	REPORTED HAZARDS	REFERENCE
		Rocks can create vantage points for basking or to aid removal of skin. Clumps of grass with soil attached			Joy, R. Perth Zoo, Enrichgment listserve 2/04
Physical	Changing furniture	Furniture can be rearranged occasionally to stimulate the animals. Change position of rocks, climbing branches (to change pathways), pieces of bark etc. Add fresh branches, or transfer from another enclosure.	All reptiles and amphibians	Major rearrangement should be undertaken only once or twice a year as animals can become confused.	Blake, E. et al. EE of reptiles. ABWAK EE Handbook Pp 43 –49 Joy, R. Perth Zoo, Enrichgment listserve 2/04 Hayes et al. Beyond mammals:… 2nd Nature
Physical	Retreats	Tubes – Cork bark, hollow log, PVC, cardboard. Boxes – of all sorts, open ended Rocks or logs to get under Some reptiles require contact on two or more sides – clear plastic sheet just above substrate can provide this and still be visible. One study found that using hanging retreats for snakes increased nocturnal activity.	Snakes Lizards		Wright, C. VA Zoo; Carroll, J. C for Rept % Amphib Prop and Cons; Dailey, A. Cincinati Zoo; Enrichment listserve 10/03, 2/04 Hayes et al. Beyond mammals:… 2nd Nature Buley, K. Jersey Zoo Newsletter
Social	Mixed species exhibit	Combined exhibits of an arboreal and a terrestrial species with similar climatic requirements can work well . Trial and error may be necessary to find compatible species. Provide sufficient basking and resting	Water dragons or iguana with turtles; Chameleons with a ground dwelling lizard	There should not be a discrepancy in size to minimise predator/prey possibilities.	Blake, E. et al. EE of reptiles. ABWAK EE Handbook Pp 43 –49

TYPE	ENRICHMENT	DESCRIPTION HOW USED	USED FOR:	REPORTED HAZARDS	REFERENCE
		sites for all individuals.	or frog. Cuban rock iguana with Basilisk	Monitor for aggression.	Wright, C. VA Zoo, Enrichment listserve-10/03
Social	Separation and re-introduction	The separation for a short period of animals normally kept together and then re-introducing them can provide stimulus and can encourage breeding behaviour. Social factors can play a big part in successful breeding. Special cages with removable solid partitions have been successfully used to breed geckoes. The partition is removed when the breeding season approaches to pair the animals.	Animals that are primarily solitary. Eg Tiliqua	Would not work for social hierarchical species In territorial lizards housing in adjacent glass walled vivaria can cause stress because they can still see their neighbours. .	Blake, E. et al. EE of reptiles. ABWAK EE Handbook Pp 43 –49 Gibson, R. Gecko Gallery. Jersey Zoo Newsletter.
Sensory Olfactory	Sloughs	Putting snake sloughs in lizard enclosure causes an increase in activity	Lizards, snakes	Infection - Slough may be autoclaved.	Wright, C. VA Zoo, Joy, R. Pert Zoo. Enrichment listserve-10/03, 2/04
Sensory Olfactory	Mammal hair	Fur from cats, microwaved to sterilize then put into waster. Water scattered into reptile exhibits. Other scents used – rabbit, ferret, giant anteater, hoofstock. Response of cruising, alert posture, tracking scent, tongue flicking were observed.	Snakes and lizards	Hair sterilized by microwave.	Burr, L. 1997 Animal Keeper's Forum: 24, p 122.

TYPE	ENRICHMENT	DESCRIPTION HOW USED	USED FOR:	REPORTED HAZARDS	REFERENCE
Sensory Auditory	Recorded sounds	Crocodiles will react to sounds of hatchlings or bellow of large male. Frog calls	Crocodilians Frogs	Use infrequently, may be stressful.	Hayes et al, Beyond mammals…2nd Nature Carroll, J. C for Rept % Amphib Prop and Cons Enrichment listserve 10/03

Data Collection Check sheet for Enrichment Evaluation in reptile species

Species: **Number of individuals:**

Baseline observations: 15 mins of observations before the enrichment is added to the enclosure.

Evaluation observations: 15 mins of observations, directly after the enrichment is added.

INSTRUCTIONS: Record **on** the 30 sec interval the number of animal(s) active or inactive. Within the interval tally how many tongue flicks were seen. If you have any other comments about the behaviour mark that in the last column. The number of animals out of sight can be worked out after the session.

Baseline: **Enrichment:** **Time added:**

Int'vl Time	*on interval* **ACTIVE**	*on interval* **INACTIVE**	**Out of Sight**	*during interval* **TONGUE FLICKS**	**Other comments**
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