Assessing reptile welfare using behavioural criteria

Clifford Warwick, Phillip Arena, Samantha Lindley, Mike Jessop and Catrina Steedman

While clinical reptile medicine as a science is in its ascendancy among veterinary surgeons and other interested groups, familiarity with the often related issue of reptilian behavioural and psychological health appears less common. Behavioural change in reptiles, as in other animals, is often the primary indicator of disturbance, injury or disease. Just as a behavioural sign may be an indicator of stress or a physical problem, a physical sign may be an indicator of a behavioural problem, and abnormal behaviour may result in injury and disease. This article focuses on abnormal behaviour in reptiles, including signs of captivity-stress, injury and disease and their aetiologies, and takes a fresh look at some old and established biological and husbandry problems. Concise diagnostic guidance on behaviour issues is also included. The article might serve to prompt questions that may be asked of reptile keepers when evaluating animal and husbandry background.

Biological and behavioural considerations

Significant differences exist between domesticated companion animal species such as dogs and cats and exotic non-domesticated pet species, which include all reptiles. Biologically, dogs and cats, along with other commonly domesticated animals including cattle and horses, possess essentially genetically ‘pre-adapted’ and ‘soft-wired’ traits allowing them to coexist (‘life-share’) with other species and the captive context. By contrast, reptiles possess few pre-adaptive features and are hard-wired with innate biological, behavioural and psychological needs that preset them to life in nature.

An inescapable factor that dramatically and negatively impacts on the biological suitability of reptiles to captivity is that, unlike dogs and cats, reptiles will almost universally be ‘life-restricted’ in small, arbitrarily and poorly conceived vivariums maintained by non-professionals. These major biological considerations and management deficiencies imbue the veterinary surgeon with onerous duties to look for overt and emerging, as well as occult, health (physical, behavioural, psychological and husbandry) issues associated with reptiles that are presented to them, irrespective of the reason for consultation.

Behavioural assessment as a tool

Contrary to common perceptions, reptiles manifest an array of abnormal behaviours that indicate stress. Behavioural assessment of animals (including reptiles) is an essential method for evaluating their condition and welfare. While physiological stress measurements are available through blood and, less invasively, faecal sampling, numerous confounding factors are involved with this method, including a dearth of pure baseline data and the limitations of focused interpretation. For example, human studies report that, while cortisol may be mediated by certain factors such as agitation-related stimuli, states including perceived stress, anxiety and depression may not increase cortisol (van Eck and others 1996). Extrapolation from these findings suggests that conditions such as understimulation in animals may not be revealed through physiological measurement (eg, corticosterone in reptiles).

Normal and abnormal behaviour in context

Reptile behavioural diversity approaches, parallels and sometimes surpasses that seen in birds and mammals (Gillingham 2004). Normal behaviour implies not only natural behaviours, but also their appropriate range and context. For example, in nature, it may be normal and healthy for an animal to spend hours of exploratory locomotor activity in order to hunt for food, whereas it may be abnormal and unhealthy for an animal to spend less than an hour pacing a small enclosure in a captive scenario with plentiful food. There is a shortage of field-based behavioural observations for the vast range of species held in captivity and this deprives captive animal observers of good comparative information. Relatedly, the inherent possible conundrum exists that some animals that may be stressed by field observations may change their habits. For example, eye contact alone between observers and free-living iguanas resulted in significant disruption of normal hierarchical perching (Burger and others 1991). Accordingly, stress-related states in captive animals in some cases could...
be underrated as ‘normal’ because they have been mistakenly based on human-invoked responses in the field.

Of course, stressors are present in nature and occur commonly. However, in nature, animals (regardless of their eventual success) are adapted to cope with specific evolved challenges in an environment that has an overall balance and suitability.

By contrast, captive conditions typically replace many features of the natural world with artificial and frequently poorly matched alternatives that deprive animals of known normal behaviour and associated biological needs, such as hunting, spatial range, and macro-habitat investigation (Arena and Warwick 2004, Warwick 2004).

**Misinterpreting common biological and behavioural signs**

Reptile sellers, keepers and some professionals commonly interpret signs of ‘good feeding’, ‘good bodyweight’ and ‘active reproduction’ as positive indicators of welfare. However, in isolation, these signs are poor indicators of welfare and may be highly misleading (Broom and Johnson 1993, Warwick 2004). Indeed, the presence of some genuinely ‘positive’ signs may not convey good welfare where any concurrent negative health or welfare sign is identified.

**Signs of abnormal behaviour and captivity-stress**

Generally, captivity-related chronic stress behaviour may result in increased abnormal behaviour, behavioural inhibition, vigilance behaviour, hiding, fearfulness and frequency of startle, aggression, and freezing behaviour, and decreased exploratory behaviour, reproductive behaviour, and behavioural complexity, as summarised by Morgan and Tromborg (2007).

However, these criteria vary according to animal class and species. Table 1 presents behavioural signs of captivity-stress in reptiles and Table 2 presents sample signs of normal behaviour, quiescence and ‘comfort’. For these summaries, the authors have adopted established behavioural assessments as summarised by Arena and Warwick (2004), Warwick (2004) and Warwick and others (2011a).

As with other assessments, many problematic behavioural issues may be ‘masked’ by acute arousal states modified by a reptile’s temporary presence and examination in the clinical environment, which can found or preclude accurate diagnosis.

**Signs of normal behaviour, quiescence and comfort**

Although totally normal reptile behaviour in the acute clinical environment is unlikely, Table 2 outlines some key signs that may assist in gauging animal condition. The presence of normal signs does not imply overall good health state where any abnormal sign is also observed. Relatedly, some behavioural signs may be ambiguous, for example, sleep may be associated with normal or abnormal behaviour or health.

---

### Table 1: Behavioural signs of captivity-stress

| Behaviour                              | Sign                                                                 | Possible cause                                                                 |
|----------------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Interaction with transparent boundaries (ITB) | Persistent (up to 100 per cent activity period) attempts to push against, crawl up, dig under or round the transparent barriers of enclosure | Related to exploratory and escape activity. Self-compounding and destructive. Inherent psychological organisation and adaptational constraints result in failure to recognise abstract invisible barriers |
| Hyperactivity                          | Abnormal high-level physical activity, surplus or redundant activity | Often associated with ITB. Overcrowding. Self-compounding and destructive. Overly restrictive, deficient and inappropriate environments |
| Hypoactivity                           | Hypothermia, disease, injury, pain, co-occupant harassment          | Too low temperature, infection/organic dysfunction, falling, dropping, co-occupant attack, transport trauma, occupant harassment |
| Anorexia                               | Hypothermia, disease, injury, pain, co-occupant harassment          | Too low temperature, infection/organic dysfunction, falling, dropping, co-occupant attack, transport trauma, occupant harassment |
| Hyperalertness                         | Abnormal high level of alertness ‘nervousness’ to environmental stimuli | Often related to fear, defence and escape behaviour. Common in overly restrictive, and exposed, deficient and inappropriate environments |
| Rapid body movement                    | Abnormal ‘jerky’ locomotor or jumping actions                       | Often related to fear, defence and escape behaviour. Common in overly restrictive, and exposed, deficient and inappropriate environments |
| Flattened body posture                 | Flattening of body against a surface often combined with hyperalertness | Often related to fear, defence and escape behaviour. Common in overly restrictive, and exposed, deficient and inappropriate environments |
| Head-hiding                            | Deliberate seclusion of head including under objects or substrate   | Often related to fear or ambient light/photo stress behaviour. Common in overly restrictive, and exposed (including excessive ambient light for nocturnal species), deficient and inappropriate environments |
| Inflation of the body                  | Deliberate (often repeated) inflation and deflation of the body. May or may not be associated with ‘hissing’ sound | Often related to fear, defence and escape behaviour. Common in overly restrictive, and exposed (including light for nocturnal species), deficient and inappropriate environments |
| Hissing                                | Hissing sound, accompanied with deliberate repeated inflation and deflation of the body | Often related to fear, defence and escape behaviour. Common in overly restrictive, and exposed (including excessive ambient light for nocturnal species), deficient and inappropriate environments |
| Co-occupant aggression                 | Aggressive or defensive displays, biting, chasing cage mates        | Often related to courtship routines, inability to avoid cage-mates when required, overly restrictive, and exposed deficient and inappropriate environments. Hunger |
| Human-directed aggression              | Mock/real strikes using jaws or tail                                | Often related to fear, defence and escape behaviour. Common in overly restrictive, and exposed (including excessive ambient light for nocturnal species), deficient and inappropriate environments. |
Clutching: Snake or lizard tightly grasps human or object. Often related to fear or ambient light/photo stress behaviour. Common in overly restrictive, and exposed (including light for nocturnal species), deficient and inappropriate environments.

Death-feigning: Animal (commonly snake) appears limp, upside-down, unconscious. Often related to fear.

Loop pushing: Snake uses ‘arch’ of body to resist/deflect physical contact from cage-mate or human. Often related to fear or ambient light/photo stress behaviour. Common in overly restrictive, and exposed (including light for nocturnal species), deficient and inappropriate environments.

Freezing: Eye contact with or general presence of observer results in freezing posture/tense immobility. Often related to fear or ambient light/photo stress behaviour. Common in overly restrictive, deficient and inappropriate environments.

Grating of jaw: Turtles and tortoises tightly rasp together ramphotheca causing an abrasive grating sound. Often related to fear or light stress behaviour. Common in overly restrictive, and exposed (including ambient light/photo for nocturnal species), deficient and inappropriate environments. Pain.

Hesitant mobility: Animal uncharacteristically moves in ‘fits and starts’. Often related to fear. Common in overly restrictive, inappropriate environments.

Wincing: Hypersensitivity to minor stimuli causing retraction of head, limbs or tail. Often related to fear. Common in overly restrictive, inappropriate environments. Pain, disease.

Prolonged retraction of head, limbs or tail: Tortoises and turtles retracting head, limbs or tail for minutes or longer. Often related to fear, pain, disease.

Open mouth breathing: Sporadic, usually slow, open-mouth respiration or gasping. Hyperthermia, infection/organic dysfunction/disease, major head/neck injury, falling, dropping, co-occupant attack, transport trauma.

Panting: Rapid open-mouth breathing, sometimes accompanied by extension of dewlap (skin flap under lower jaw in lizards). Also, cloacal evacuations may occur. Hyperthermia.

Cloacal evacuations when handled: Urination, defecation, excretion of malodorous substance from cloaca. Often related to fear.

Projection of penis or hemi-pene: Projection of penis or hemi-pene associated with human presence or contact. Often related to fear.

Voluntary regurgitation of food: Regurgitation of food associated with human presence or contact. Often related to fear.

Tail autotomy: Voluntary autotomy of tail (some lizards) associated with human presence or contact. Often related to fear.

Pseudovocalisation: Crocodilians, some lizards and turtles producing squeaks or whines (aside from sexual context). Often related to fear, physical irritations, pain, injury, disease.

Venom spitting: Venomous snakes ejecting venom associated with human presence or contact. Often related to fear.

Squirting blood from eye: Some lizards eject blood from eye associated with human presence or contact. Often related to fear.

Pigmentation change: Typically some lizards (especially chameleons) change colour – may be rapid or slow. Often related to fear, pain, hyperthermia, hypothermia, overly restrictive, deficient and inappropriate environments, injury, disease.

Atypical locations: Reptile occupies an atypical location for an unusual amount of time or other unusual context (e.g., an arboreal chameleon on cage floor). Often related to disease, injury, discomfort, co-occupant aggression, hyperthermia, hypothermia.

Table 2: Behavioural signs of quiescence and ‘comfort’

| Behaviour                              | Sign                                      | History                                      |
|----------------------------------------|-------------------------------------------|----------------------------------------------|
| Normal/relaxed alertness               | Relaxed interest/awareness in proximate or novel objects, relaxed visual explorations | Normal environmental investigation          |
| Calmly smelling or tasting objects or air | Calm chemical sample of surrounding         | Normal environmental investigation, food searches |
| Subtle changes in body posture and orientation | ‘Stretching out’ of limbs while basking, relaxed adaption of body angles using furnishings, etc | Normal thermoregulatory behaviour and rest |
| Unhurried body movements and locomotion | Relaxed environmental exploration           | Normal environmental investigation, food searches |
| Moderate to relaxed grasp on handler or object | Snake or lizard maintains relaxed (but possibly firm) grasp on human or object | Normal relaxed behaviour and rest |
| Relaxed drinking                        | Unhurried drinking                         | Normal maintenance behaviour                |
| Relaxed feeding                         | Unremarkable feeding habits                | Normal maintenance behaviour                |
| Relaxed breathing                       | Unremarkable breathing habits               | Normal relaxed behaviour                    |
| Physical quiescence                     | Unremarkable relaxed activity, eg, free from apprehension and fear activities | Normal relaxed behaviour                    |
Physical signs of behavioural problems

A physical sign (such as an injury or topical infection) may be an indicator of an environment-related behavioural problem. For example:

- Rostral lesions may be associated with interaction with transparent boundaries (ITB). Fig 1 shows an example of ITB, which is a common and often persistent (up to 100 per cent activity period) captivity-stress-related behavioural problem involving attempts to push against, crawl up, dig under or round the transparent ‘invisible’ barriers (typically glass) of enclosures; Fig 2 shows friction lesions resulting from this abnormal behaviour.
- Ventro-mandibular lesions may be associated with arboreal species diving and/or dropping onto hard surfaces.
- Thermal ‘contact’ burns (typically on the dorsal region) may be associated with deficient overall temperatures, thermal gradation or basking facilities.
- Head and extremity injuries and infections may be associated with co-occupant aggression or courtship behaviour in overly restrictive environments with insufficient escape zones. Fig 3 shows a maxillary abscess in a lizard caused by a co-occupant bite, and Fig 4 shows a limb bite abscess in a terrapin, also from co-occupant aggression.
- Ventral dermatoses may be associated with hypoactivity behaviour in overly restrictive environments.
- Intestinal impactions may be associated with pica (substrate-eating) in under-stimulating environments. Fig 5 shows a radiograph of a severe ‘pica’ (lithophagy)-related gastrointestinal impaction in a tortoise. Fig 6 shows a sample of evacuated cage gravel from the same animal.

Although this article is primarily about behaviour rather than general husbandry, it will include two physical environmental issues with close biobehavioural associations – spatial and thermal considerations – and examine more closely particular issues within each subject.

Spatial considerations

Many reptiles are mistakenly and inhumanely kept in small cages due to erroneous advice handed down from one pet trader, hobbyist or ill-informed keeper to another. Common false understandings are that many reptiles ‘feel safer’ in small environments and that they are naturally ‘sedentary and don’t need space’. This rationale may suit the convenience of those seeking to promote reptiles as a ‘cage pet’, but it is scientifically and ethically wrong.

While reptiles, like other animals, require shelter to which they can voluntarily withdraw, the key elements are that the animal seeks a ‘hiding place’ when it senses the need for it and it does this voluntarily. Imposing a confined space on an animal is biologically equivalent to trapping it.

Home range studies of reptiles have frequently shown them to be highly active and that they travel either within local ranges of several hundreds of square meters or indefinite ranges measured in hundreds or thousands of kilometres. For example, arboreal monitors have been documented moving daily ranges greater than 186 m, home ranges for some skink lizards are 1 ha, box turtles 40 ha, indigo snakes 158 ha, and for sea turtles, travel can be measured in the thousands of kilometres.

Environment

The components of artificial environments are notoriously complex, involving issues that include, but are not limited to, space, temperature, humidity, light, airflow and furnishings – each with its own array of known (and often more importantly unknown) key factors. Winning the National Lottery involves getting six correct variables out of 49 to beat a 1 in 14.5 million chance. In husbandry, the chances of six correct variables out of thousands of dynamic variables are very small and this may partly explain why many reptiles do not survive long in captivity.
Small species and juveniles commonly utilise as much, and sometimes more, total space than large species and adults. Smaller forms are often insectivorous and these may need to feed more frequently than larger forms and also require a great deal of activity to track and catch their highly active prey.

Regardless of these differences, all reptiles are active, including species such as pythons that are popularly, but wrongly, perceived as sedentary. Some species, in particular large carnivores such as monitor lizards and pythons, may adopt brief sedentary periods following consumption of large meals, but this is a transient phase and not one that should be used to judge an animal’s general activity pattern or spatial needs.

**Postural-positional orientation**

Not only is significant free space essential for normal behaviour and welfare, but the spatial landscape is also important to accommodate an animal’s postural-positional orientation.

All reptiles appear to seek out and occupy ‘angles’ and orientations (sometimes highly subtle). These postural-positional desires appear to play roles in delivering comfort and focused thermal needs, as well as in the amelioration of discomfort. Accordingly, a snake that needs to adopt a straight-line posture to relieve intestinal discomfort cannot do so in a cage that is shorter than the snake itself. Fig 7 presents an example of severe spatial restriction where the snake cannot voluntarily adopt a straight-line body posture.

Therefore, merely providing a branch to bask on or a hide to retreat to is inadequate.

**Good cage, bad cage**

It may be unwise to attempt to set or promote ‘appropriate’ or ‘adequate’ spatial needs and cage sizes, as in the restrictive captive setting this arguably equates to ascribing a positive connotation to what is in effect a negative situation. Even well considered cage-size recommendations effectively amount to an acceptable safe minimum.

**Overcrowding and crypto-overcrowding**

Overcrowding is manifested in two ways, ‘overt overcrowding’ and ‘covert (or crypto) overcrowding’. Excessive numbers of animals occupying a certain amount of space determines overt overcrowding. Crypto-overcrowding essentially refers to the availability of all facilities to all animals when they require access to those facilities.

Accordingly, an enclosure that appears large and abundant but that lacks the ability to ‘service’ all animals’ needs at any time is capable of being overcrowded by way of other inherent deficiencies. Therefore, in order that a space is not overcrowded, it must allow both space to roam as well as possess sufficient facilities – for example, a water bowl or basking site – that all animals can use together at any one time (Warwick and others 2011b).

Fig 8 presents an example of severe overt overcrowding where the baby turtles depicted obviously cannot occupy land space or utilise basking heat facilities. Fig 9 shows crypto-overcrowding where the baby turtles can occupy limited land space, but cannot all utilise the basking heat facility at one time.
Thermoregulatory issues
Reptiles naturally use behaviour to select and occupy niche temperatures and attain precise thermal conditions. Inability to thermoregulate within precise, self-perceived (by the animal) needs and even with regard to a single event may result in the exacerbation of acute stress as well as chronic debilitation.

Behavioural fever and stress
In reptiles, the fever response is primarily behavioural rather than physiological. ‘Behavioural fever’ is manifested by the compromised animal directly seeking higher than usual temperatures by selecting warmer zones.

Similarly, healthy but ‘stressed’ reptiles, such as those that react poorly to handling or to intraspecies competition, may show ‘emotional fever’ and seek out higher temperatures until they ‘settle’. It is probably important that they can seek raised temperatures after even minor stressor events. Handling may equate to capture and predation.

Voluntary hypothermia
In addition to voluntary hyperthermia, there is also voluntary hypothermia, a state where some injured or diseased animals appear deliberately to seek out lower optimum or very low temperatures. Clearly, climatic factors may stimulate hypothermia such as animals that seek to hibernate following the onset of a naturally cooler environment. Where injured or diseased reptiles are concerned, it may be helpful to take into consideration that voluntary hypothermia may be a requirement for some animals to survive a problem, most likely because reduced microbial growth, physiological disturbance and ‘quiescence’ and healing may in some cases result from a compromised animal’s ‘biological shutdown’. However, the strategy should be regarded cautiously in sick individuals and should not always be presumed or accepted as positive. Identifying this state is difficult, but may be a useful differential for the clinician.

Appropriate thermal gradients are essential for health maintenance. The need to alter body tempera-
References
ARENA, P. C. & WARWICK, C. (2004) Miscellaneous factors. In Health and Welfare of Captive Reptiles. Eds C. Warwick, F. L. Frye, J. B. Murphy. Chapman & Hall/Kluwer. pp 263-283
BROOM, D. & JOHNSON, K. G. (1993) Stress and Animal Welfare. Chapman and Hall/Kluwer. pp 80-82
BURGER, J., GOCHFIELD, M. & MURRAY, B. G. (1991) Role of a predator’s eye size in risk perception by basking black iguanas, Ctenosaura similis. Animal Behaviour 42, 471-476
GILLINGHAM, J. C. (2004). Normal behaviour. In Health and Welfare of Captive Reptiles. Eds C. Warwick, F. L. Frye, J. B. Murphy. Chapman & Hall/Kluwer. pp 131-164
MORGAN, K. N. & TROMBORG, C. T. (2007) Sources of stress in captivity. Applied Animal Behaviour Science 102, 262-302
VAN ECK, M., BERKHOFF, H., NICOLSON, N. & SULON, J. (1996) The effects of perceived stress, traits, mood states, and stressful daily events on salivary cortisol. Psychosomatic Medicine 58, 447-458
WARWICK, C. (2004) Psychological and behavioural principles and problems. In Health and Welfare of Captive Reptiles. Eds C. Warwick, F. L. Frye, J. B. Murphy. Chapman & Hall/Kluwer. pp 205-238
WARWICK, C., LINDLEY, S. & STEEDMAN, C. (2011a) How to handle pets: a guide to the complexities of enforcing animal welfare and disease control. Environmental Health News 8, 18-19
WARWICK, C., LINDLEY, S. & STEEDMAN, C. (2011b) Signs of stress. Environmental Health News 10, 21

Further reading
FRYE, F. L. (1991) Biomedical and Surgical Aspects of Captive Reptile Husbandry. 2 vols. Krieger Publishing
KREGER, M. D. (2002) Laboratory housing of reptiles and amphibians. In Comfortable Quarters for Laboratory Animals. Ed V. Reinhardt. Animal Welfare Institute. http://awionline.org/pubs/cq02/Cq-amph.html. Accessed February 26, 2013

Self-assessment test: Assessing reptile welfare using behavioural criteria

(1) Which of the following types of lesion is seen in pictures A and B?
   a. Co-occupant bite
   b. Thermal burn
   c. Chronic dermatitis
   d. Injection site infection

(2) What could be the aetiologies?