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Behaviour in the Wild and in Captivity

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Introduction

Little has been written on the behaviour of captive reptiles that is useful for the practising veterinarian. It is important that the clinician is able to distinguish between normally occurring behaviours and what is pathological. Owners and keepers may report behaviours as unusual when they are not. Animal behaviour, together with structure and function, are the three phenotypic manifestations shaped through natural selection and adaptation. It can be difficult to distinguish between pathophysiological responses and normal ethological components of reptilian behaviour. Often, disease will manifest as a direct result of behavioural factors. Observed behaviours in reptiles are often directly related to thermoregulatory and other physiological requirements. This chapter highlights some unique features of reptilian structure, function and behaviour pertinent to the exotic animal consultation.

Normal Needs and Behaviour of Captive Reptiles

The physical, social and behavioural requirements of captive reptiles have been described (Greenberg 1992):

Box 3.1 A hierarchy of reptilian needs.

Homeostasis:	Thermoregulation, nutrition, water balance.
Safety	Predator evasion, hibernacula.
Sociality	Daily or seasonal social behaviour (predatory behaviour, social and reproductive behaviour, migration for food or reproductive sites, torpor).
Social dominance:	Does the animal manifest priority of access to valued resources (Figure 3.1)?
Reproductive success:	Fitness, fecundity.

(Greenberg 1992)

Inextricably linked with this hierarchy of needs is the issue of animal welfare. General criteria for the welfare of captive animals have been previously described in the literature as the ‘five freedoms of animal welfare’ (freedom from hunger and thirst, discomfort, pain, injury and disease, fear and distress, and freedom to express normal behaviour). Trends in captive animal management are now moving beyond the five freedoms towards a life worth living. The absence of suffering is not necessarily good welfare. Animal care needs to be directed at more than mere survival, minimum standards or ability to reproduce. Keeping standards should include validated

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Figure 3.1 Male eastern water dragon assuming a dominant posture.

Figure 3.2 An outdoor enclosure provides a natural environment for a red-bellied black snake.

enrichments, replacing negative experiences with positive ones (Figure 3.2).

Physiological Responses

Health problems in captive reptiles can be related to an aspect of reptilian physiology or behaviour rather than to a primary disease process. Physiology and structure–function relationships have been shown to be important principles of normal species-specific behaviour. Physiological parameters to be considered when assessing normal behaviour in captive reptiles are thermoregulation, postprandial metabolism, olfaction, vision, chemosensation, water exchange, feeding response, digestion, respiration and circulatory factors (see Chapter 2 for more detailed information). Consequently, disease in captive reptiles is more often than not a manifestation of incorrect or inappropriate husbandry practices affecting these processes.

Body Temperature and Ectothermy

Reptiles are termed 'ectothermic' because they are dependent upon external heat sources rather than internal heat production. Unlike in endothermic animals such as mammals and birds, metabolic heat production in reptiles is usually insufficient to raise the body temperature significantly above that of the ambient surroundings. Two important consequences of ectothermy are highly relevant to husbandry.

First, energy use derived from food or fat stores is lower because metabolic heat is not required to maintain body temperature. The food requirement is further lowered by behaviours that entail relatively long periods of inactivity. The extent to which food requirements are connected with both body temperature and activity varies with species and the circumstances of captivity. Weight loss due to excessive energy expenditure related to 'escape' or exploratory activity can occur while in new or inadequate enclosures, with conspecific aggression or related stress and disease or parasitism. Collectively, these signs are termed maladaption.

Second, reptiles are not poikilothermic (cold-blooded) and most are capable of very precise thermoregulation by behaviour. Maintaining a prolonged constant body temperature is not required physiologically in most cases and can be harmful. Variability of body temperature has importance with respect to species variation, seasonal acclimatization, feeding and nutrition, activity reproduction and disease.

Thermoregulation can occur by:

- movement between a heat source (e.g. sunlight, warm substrate) and a heat sink (e.g. shade, water, burrow)
- postural adjustments (e.g. changes in body volume, shape orientation, posture; Figure 3.3)
- physiological responses (e.g. heat production in muscle tissues in some species,

Figure 3.3 A juvenile perentie thermoregulating in a spread-eagled posture.

colour changes, circulatory changes and ventilatory adjustments to increase water evaporation from mucous membranes).

At high temperatures reptiles may pant or gape. Captive animals should not be kept in conditions where they are exposed to high temperatures without the opportunity of 'behavioural avoidance'. Conversely, at temperatures below the regulated range reptiles become torpid and sluggish and digestion ceases.

Preferred Body Temperature

Care of reptiles requires knowledge of the unique thermal requirements of a species. Preferred body temperature is species, and sometimes subspecies, dependent. In captivity, diurnal and/or arboreal species require a radiant heat source, whereas nocturnally active and/or predominately terrestrial species may avoid a photothermal (light and heat) source and may prefer a thermally variable substrate or subfloor heating. In most cases, however, a daily thermal cycle or behavioural access to thermal variation is desirable (Figure 3.4). Decreased environmental temperature plus a reduced photoperiod will stimulate oogenesis and spermatogenesis. Snakes and lizards become more aggressive with higher temperatures, especially above the preferred body temperature.

Body Temperature and Disease

Inappropriate thermal exposure can suppress the immune systems of reptiles and can operate in conjunction with other forms of stress imposed by captivity. The inability to cool below activity temperatures for prolonged periods can affect appetite and reproduction. Bacterial infections can induce reptiles to select a body temperature several degrees above 'normal' levels. Elevated body temperature enhances the survival of animals infected with a potentially lethal pathogen. It is therefore bad husbandry to cool sick reptiles.

Figure 3.4 A shingleback skink is freely able to move to or away from a heat source.

Light and Photoreception

Both the quality and quantity of light have important consequences for the physiology and health of captive reptiles (see Chapter 6 for more detailed information). The eyes are the main receptors for light; however, the pineal gland (the third eye) and possibly the skin also have some role to play. Annual cycles of day length may affect appetite, metabolism and reproduction. However, environmental temperature rather than light appears to be the more influential factor affecting reproduction.

Unlike their mammalian counterparts, nocturnal snakes have small eyes compared with diurnal snakes. Geckos and most nocturnal mammals have large eyes, owing to their sole reliance on vision. Nocturnal hunters (snakes) rely upon a combination of scent, heat and vision (Figure 3.5). Most snakes and lizards have well-developed vision as well as a chemosensory system. Recent studies reveal that reptiles may perceive 'light-flicker', such

Figure 3.5 Common tree snakes are nocturnal hunters (courtesy of M. Wilson).

as that produced by ultraviolet lights connected to alternating current sources (Woo *et al.* 2009).

Chemoreception and Acoustic Sensation

Chemoreception in reptiles uses a combination of the olfactory system, taste buds (not in all squamates) and the vomeronasal system. Most squamates use visual and chemical signals for communication (geckos also use acoustic signs). Crocodiles also respond to acoustic stimuli. Chemoreception occurs in reptiles by tongue-flicking over the vomeronasal organ – paired sensory organs in the rostral aspect of the upper mouth (Figure 3.6). Tongue-flick rate is an accurate and proportional measure of a snake's level of interest in its environment, particularly while searching for food. Tongue-flicking of captive elapids often indicates that they are about to defaecate. Flicking usually ceases once elimination is complete. Tongue-flicking may also be a sign of distress. Some keepers recommend not cleaning a hide box too scrupulously, leaving an odour for the snake to sense. Other keepers recommend the keeping of a small amount of faeces in a pot within the vivarium to satisfy the olfactory needs of the captive reptile.

Water Exchange and Humidity

Reptiles lose water by evaporation across the skin and respiratory membranes and by excretion (urine and faeces). Evaporation may account for more than half of the total water loss. As a result, exposure of captive reptiles to inappropriate levels of ambient humidity

Figure 3.6 A yellow-faced whip snake tongue flicking.

(if terrestrial) or salinity (if aquatic or amphibious) can alter hormone levels, cause weight loss and suppress reproduction.

Digestion and Nutrition

The rate of feeding varies with a multiplicity of factors, including species, animal size, age, temperature, activity, reproductive status, season, disease, parasite burden and stress. If a 'healthy' reptile habituated to captivity refuses food, the item should be removed until the next scheduled feeding.

Gastrointestinal transit times vary from species to species. While some reptiles, especially skinks, produce faeces within hours of feeding, others may retain faeces for months. Passage of faeces is facilitated by warmth and activity. Retention of gut contents can aid in water absorption. Recently fed reptiles need warmth and seclusion. Digestion ceases at low temperatures and food can putrefy in the gut of a cool animal.

Respiration and Circulation

Temperature change, excitement, activity and ecdysis can produce marked changes in respiration.

Pain and Stress

Pain perception and stress in reptiles and the resultant physiological responses are not well understood. For example, handling is a common stressor in captive reptiles. Improper handling, in addition to crowding and poor hygiene, can produce physiological deterioration leading to reduced growth, suppressed reproductive capacity and increased mortality from disease. Often, sick animals presented for veterinary examination have a history of over handling. Similar to birds and mammals, reptiles in pain will often exhibit aggressive behaviour. Snakes suffering from mite infestation will seek water for soaking to ease their discomfort.

Behaviour Patterns of Captive Reptiles

Behaviour patterns may be divided into maintenance and distance-reducing behaviours. Captive environments can easily create behavioural and spatial restrictions, leading to maladaptive reactions such as hyper- and hypoactivity, co-occupant aggression, variable environmental temperature preferences, interaction with transparent boundaries, aggression and adaptability.

Maintenance Behaviours

Maintenance behaviours include feeding and thermoregulatory responses.

Feeding

Prehension, chewing The scleroglossa (geckos, snakes and monitor lizards) have prehensile jaws and actively seek out foods via sensory capabilities. Iguania (iguanas, chameleons) lack these characteristics and wait for the food to come to them. They capture food with their sticky tongues.

Heat sensing pits Most pythons, except the reptile eaters (*Aspidites* spp., womas and black-headed pythons) possess heat sensing (labial) pits, small indentations in the upper and lower jaws. These infrared sensory organs work in conjunction with the visual system in seeking prey. It is also thought that infrared imaging systems may also be used for finding basking sites and shelter.

Constriction Pythons, usually ambush hunters, strike violently when prehending their prey. The food item is then constricted and swallowed. Womas and black-headed pythons, being reptile-eating ground dwellers, will often push prey items up against a firm surface instead of constricting them, an adaptive behaviour useful in a burrow, where there is insufficient space for constriction.

Envenomation Elapids (most of the Australian venomous snakes) will strike and then release, following the prey for a few minutes after the attack to consume it. Some venomous snakes, such as brown snakes, constrict as well. It has been proposed that this is due to the short fangs in this species. Colubrid snakes will swallow prey items live in the wild.

Captive Feeding Routines

In order to train pythons to strike only at prey items, thereby reducing potential distress or injury to keepers, it is preferable to feed snakes in a container separate from their enclosure. The pythons should be accustomed to handling by gentle lifting with a probe or jigger every one to two days. The snake becomes used to being handled and lifted from its enclosure and will usually not strike. Despite being social reptiles, bearded dragons, especially juveniles, may need to be fed separately. Males tend to 'bully' females, dominating the food supply. Turtles often bite each other when feeding, particularly on the hind limbs and tail.

Hyperactivity and Hypoactivity

Reptiles will become hyperactive at ambient temperatures above their preferred body temperature. Signs of heat stress will become evident if the temperature increases above a tolerable level. These signs include panting and mouth gaping in lizards, hyperactivity, escape behaviour and seeking the point furthest from the heat source. Hypoactivity will occur when reptiles are kept below their preferred body temperature or preferred optimal temperature zone.

Distance-Reducing Behaviour

Distance-reducing behaviours include aggregation, courtship and mating, post-ovipositional, territorial, combat and anti-predator behaviour.

Social or Solitary?

It is important to know which species are naturally gregarious and which prefer to be solitary. Sometimes reptiles within one genus will display wide variations in social behaviour. Bearded dragons can be successfully kept in a harem situation with one male and several females; however, two males will often fight when placed in the same enclosure. Cannibalism is common in Antaresia species (children's pythons etc.), Aspidites species (womas and black-headed pythons) and most of the Elapidae.

Head Bobbing, Hand Waving, Digging, Tail Whipping

Bearded dragons of both sexes 'head bob' and wave their forelimbs. Males do it more vigorously. Females are more submissive and tend to mimic the behaviour of their male cage mate.

Courtship and Mating

After a period of cooling to stimulate spermatogenesis, males of most species of reptile will eat and enter a period of hyperactivity and mate-seeking behaviour. Males will also engage in mock combat. Snakes, monitors and skinks particularly show this behaviour. The beards of male bearded dragons turn black when they are sexually mature and active.

The Gravid State

A gravid python will typically expose its ventrum and shiver periodically. Pre-ovipositional anorexia is common. Dragons, chameleons, monitors and turtles will exhibit digging behaviour just prior to oviposition. Egg laying usually occurs within 24 hours. Often, pythons will become restless after oviposition and egg removal. Artificial eggs or egg shells from earlier clutches can be introduced to settle the snake.

Maternal Incubation

Morelia spp. are particularly good at maternal incubation of eggs. The snake will wrap around its eggs and shiver sporadically. The eggs may be left alone for extended periods as the female basks opportunistically and then returns to the eggs, maintaining them at a temperature of 29–30 °C and a humidity of approximately 65%. The female may not eat during the incubation period and will become protective and more aggressive.

Mock Combat

Male reptiles of many species engage in ritual or mock combat. This is particularly prevalent in lizards, monitors (Varanidae) and elapid snakes (Elapidae) and normally occurs in the mating season (Figure 3.7). Male pythons 'pace' the enclosure when they are ready to mate, appearing as if they are hungry. Defensive behaviours may be more prevalent during handling or attempts at handling, such as:

- catalepsy, tonic immobility
- tail flicking, tail autotomy
- eversion of hemipenis or phallus
- excretion of faeces, urine, urates, scent gland excretion (turtles)
- bluff and threat displays (Figure 3.8)
- colour change
- shedding skin

Figure 3.7 Two adult male lace monitors engaged in mock combat.

Figure 3.8 Shingleback skink in a bluff defensive posture.

Figure 3.9 Excessive constriction when handling is an indicator of stress.

- constricting, balling (Figure 3.9)
- withdrawal of head, limbs and tail (chelonians)
- striking or attacking.

Fitness and Environmental Enhancement

Lack of fitness appears to have a negative effect on normal physiological responses in captive reptiles. Attention should be paid to the captive environment to maximize the opportunity for snakes to move around the exhibit and maintain muscle tone and strength.

Pythons

While most species of pythons spend a substantial part of the time on the ground, several species are also climbers, such as *Morelia spilota* (carpet and diamond pythons). In captivity, the opportunity to climb is not often provided. Captive pythons are predisposed to dystocia. Decreased muscle tone, reduced strength and lack of fitness may be mitigating factors in this process.

Green Pythons

In captivity, green pythons spend most of the time coiled on a perch (Figure 3.10). These snakes are much more active in the wild,

Figure 3.10 Captive green pythons spend much of their time perching.

Table 3.1 Signs of comfort and discomfort in captive reptiles (adapted from Warwick 1995).

Comfort	Discomfort
Alertness	Hyper-alertness
Relaxed state	Escape attempts, repeated inflation/deflation cycles
Calmly smelling or tasting objects	Mock or actual attacks
Subtle changes in body posture	'Clutching' object or handler
Gradual body movements and locomotion	Feigning death
Moderate to relaxed grasp on handler	Hiding head
Normal to relaxed breathing	Inflation of the body
Sleeping	Rapid gular pulsation
Absence of signs of discomfort	Open-mouth defence posture
	Open-mouth breathing
	Defecation with handling
	Projection of penis or hemipenis
	Regurgitation
	Vocalization (crocodile, gecko)
	Pigmentation change

preferring to move or climb vertically as they hunt or seek a mate. Suggestions for improving captive conditions include the provision of more opportunities to climb. Enclosures tend to be very sterile and not enriching. Keepers of this species tend to be more focused on providing the perfect temperature and humidity and little else. Offering a thermal mosaic could stimulate snakes to move around the cage more.

Signs of Comfort and Discomfort

The comfort or discomfort of a captive reptile may be determined by assessing for the presence or absence of certain behavioural and physiological responses (Table 3.1).

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