Dermatological diseases of snakes and lizards and how to investigate them

Snake and lizard skin is highly adapted to being tough and impervious, reflecting their evolutionary emergence in a more arid lifestyle. These special features include the formation of scales and the need to shed the skin at intervals to permit growth. To the clinician, these adaptations present a different range of diseases compared to those in more 'routine' species, most of all, the need for a different approach to their investigation. This article looks at the most common clinical signs of dermatological diseases in snakes and lizards and explains how to investigate based on the differential diagnoses for each sign.

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Snakes and lizards are commonly seen in practice now. Large numbers of certain species, such as Royal or 'Ball' pythons (*Python regius);* Inland Bearded dragon *(Pogona vitticeps) and* Veiled chameleon *(Chamaeleo calyptratus),* are bred readily in captivity, so are relatively inexpensive to purchase and are thus widely kept. Therefore, there is a growing expectation that all veterinary practitioners should be able to examine and treat these species - and also the lower financial investment in the animal may result in decreased incentive to seek out more specialised vets, to pay for more involved investigations, or to drive further to these centres

The special features of snakes' and lizards' highly adapted skin include the formation of scales and the necessity to regularly shed the skin at intervals to allow their growth. This inevitably presents a different range of diseases to the mammals more normally seen in small animal clinics and requires a different approach to their investigation (*Figure 1*). Most importantly, when dealing with reptiles, their poikilothermic status means that environment and husbandry issues are particularly important to consider and a full husbandry evaluation must be carried out in all cases.

While a wide range of species may be encountered in practice, the differential diagnoses discussed in this article are seen commonly across many of these species groups.This article looks at the most common differential diagnoses based on clinical signs and discusses a practical approach to investigating these cases, as well as how to treat or manage them.

In this article drug doses are not given as they may vary between the many species, and because reptile therapeutics is a rapidly evolving field, meaning dose rates are often changing. Readers are encouraged to research drug doses regularly in referenced formularies (Carpenter and Harms, 2022; Hedley, 2023) and in the wider peer-reviewed literature.

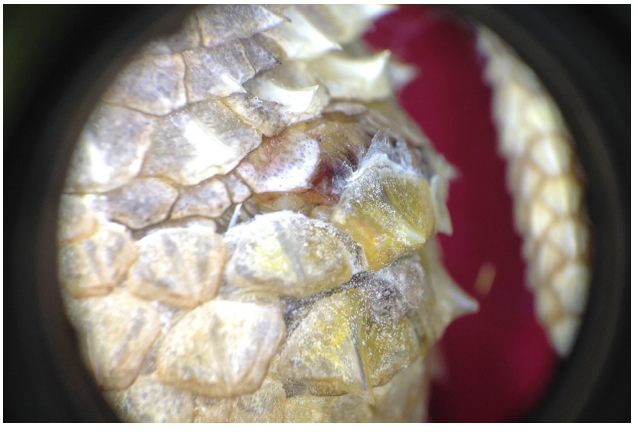

Figure 1. Magnification can be a great help when examining skin lesions - pictured here is an inflamed, infected scale.

Role of environment and stress

Environment and stress play major roles in development of reptile disease, including skin disease. These stressors will also affect prognosis, as effects on the reptile's immune system will influence the degrees of pathogenicity and invasiveness of potential pathogens. A variety of factors contribute to the environmental stress on reptiles.

Husbandry factors

Husbandry factors are paramount in the development of reptile disease. As such, a full husbandry review must be carried out in

all cases. Before embarking on the treatment of reptiles, clinicians need to be aware of:

- How to take a history and conduct a husbandry review
- The accepted needs and standards of keeping for the species they are seeing.

A full review of conducting a husbandry review is beyond the scope of this article and the reader is directed to the further reading section at the end.

Table 1 summarises the basics of what needs to be known.

Social factors

As well as permitting spread of organisms that may be commensal in one species, yet pathogenic in another, mixing of species in co-habitation may be stressful to one or more of the species. This may result in immunosuppression, encouraging the invasiveness and subsequent spread of potential pathogens.

Even in single species groups, inappropriate social groupings may result in stress and immunosuppression. Most reptiles are solitary and generally should be housed alone. However, some will permit housing in small groups. For example, Bearded dragons may be kept in small groups of one male and 2–3 females, as long as there is sufficient space and resource. However, as Bearded dragons and other reptiles can be hard to definitively sex, it is easy to get the grouping wrong. Groups with multiple males may experience direct male–male aggression. This may be physical, but can also be much more subtle with displays, such as head bobbing

Table 1. Essential information for a reptile husbandry review

Parameter	How to gather data	Text
Vivarium set up	• Direct questioning • Pictures and videos	• Type of vivarium • Size (three dimensions) • Materials • Climbing materials • Hide and humidity chamber provision • Substrate type. Does substrate feel wet or dry? • How often cleaned, and disinfection regime
Social groups	• Direct questioning • Pictures and videos	• Number of animals • Species housed together • Sexes, if known • How long owned – including recent additions • Source of animals • Were new animals quarantined – if so, how long for?
Temperature	• Direct questioning • Recorded data or downloaded data from loggers	• Type of heating – for example overhead source, or mat • Recent changes? • Is heating provided 24 hours? • Temperature range – hot and cool areas, day and night. • Thermostat provision – if provided, what is the setting? • How is it measured and how often (or is measurement continuous)? Maximum–minimum thermometers; temperature data loggers; 'heat gun'; direct observation of thermometer readings. If the latter two methods, how often is this done? • In which part of the vivarium does the animal spend most time? Hot or cold? Sat on heat mat? • Length of time spent outside the vivarium
Humidity	• Direct questioning • Recorded data	• How is this measured? • What is the range of humidities? • Is a humidity chamber provided? If so, how often is it checked, and contents replaced or wetted? • If not measured, how often is the vivarium sprayed or misted? • Is a water dish provided?
Ultraviolet (For detailed information on this subject, see http://www.uvguide.co.uk)	• Direct questioning • Recorded data	• Is UV provided? • What type of bulb? UV only or heat and UV? • When was it last replaced? If recently, how old was the previous bulb? • How long is it on for? • Is it measured? If so, how? And how often? • Is there any shielding between bulb and animal? • How far is the bulb from the animal? • Presence of a reflector
Diet	• Direct questioning • Pictures and videos • Feeding records (especially for snakes)	• What is fed? What is taken? • Source of food? • How often is the animal fed? In the case of snakes, how often is food refused? • If anorexic, how long for? • How is food provided? • Are live invertebrates removed if not eaten?

Figure 2. Snake mites around the eye of a Bearded Dragon.

and driving subordinate males away from food and heat sources. As such, some keepers suggest that if in doubt, Bearded dragons should always be kept on their own.

Parasites

In the UK the vast majority of reptilian pets are captive bred, so ectoparasites are extremely rare. However, two may be seen in pratcice.

Snake mite (*Ophionyssus natricis)*

These are commonly found on both snakes and lizards and may accumulate under scales or around the eyes (*Figure 2*), nostrils and other apertures. They may cause direct irritation and lead to hyperkeratosis and ulceration. Infected animals may spend more time in the water bowl in an effort to remove mites. The mites may also be an important vector of disease, such as arenavirus in snakes. Treatment (all reptiles should be treated each time) may involve ivermectin (topically on affected areas, or systemically), but this should not be used in indigo snakes, skinks or chelonia, or fipronil spray carefully applied to affected areas. Care must always be taken when using fipronil spray as alcohol fumes may be toxic to the reptile. For this reason, the author avoids this agent in very small or young animals.

After application of fipronil, reptiles must be placed in a warm well-ventilated place for 30–60 minutes to allow drying. Treatment also involves environmental control, as a majority of the mite's lifecycle is off the animal. All organic materials in the animal's vivarium should be destroyed and plastic materials washed in warm soapy water. The rest of the vivarium may be sprayed with ivermectin- or fipronil-based sprays and allowed to air dry. Both animal and environmental treatments should be repeated monthly until no more mites are found.

Prevention involves effective quarantine of new animals before entry to a collection and systemic treatment with ivermectin at least twice during quarantine. In large, complex, or naturalistic enclosures, or where chemical control is not effective, biological control using *Cheyletus eruditus* mites should be considered.

Myiasis

Where animals are kept outdoors (or in conservatories or greenhouses), fly strike is occasionally seen. It is generally seen infecting untreated wounds and certainly represents issues with husbandry and observation. The outlook is usually guarded to poor depending on the amount of tissue necrosis and depth of maggot invasion. Treatment involves physically removing the maggots and fly eggs; topical treatment with either ivermectin or F10 insecticide spray (cypermethrin plus piperonyl; Health & Hygiene Pty, SA); and systemic ivermectin. Wounds should be thoroughly cleaned and repaired, or allowed to granulate, and all underlying factors must be corrected.

Clinical presentations

The following section gives a basic guide to approaching different presentations of dermatopathies in snakes and lizards.

Wounds

Wounds are common, but are rarely suitable for suturing and first intention healing (although this should be the route of choice where possible). Most wounds need to be managed and allowed to heal by second intention.

Initial management will include cleaning and removal of contaminated material, which may require sedation or anaesthesia. If the animal is debilitated or severely damaged, it is advisable to first stabilise for a period (possibly of several days) using fluids, assist-feeding and keeping in suitable conditions in terms of heat and ultraviolet. Additional sampling (including blood sampling) may be required to assess for underlying disease.

Use systemic antibiotics and analgesia as required. Ideally, antibiotic choice should be based on culture and sensitivity (either swabbing of underlying tissue after removal of contaminated tissue, or culture of underlying tissue taken by biopsy). However, it is likely that empirical dosing will be needed initially. If anaerobic involvement is not suspected, then licensed fluoroquinolones may be sufficient. However, if anaerobes are suspected (bite wounds) then broader spectrum antibiosis is required, for example trimethoprim-sulphonamide; fluoroquinolone plus metronidazole (with care in herbivorous reptiles); or ceftazidime.

The effect of analgesia is poorly understood in reptiles, with few trials demonstrating efficacy, and marked differences are seen in different species. For short-term use, meloxicam may be used via subcutaneous or intramuscular injection in the cranial half of the body, or tramadol may be given intramuscularly in the caudal half.

For the application of topical hydrophilic dressings, the author will typically use either wet-to-dry dressing, or a 50:50 mix of a hydrophilic gel and silver sulfadiazine cream applied daily after cleaning.

Once the tissue has properly demarcated, the wound may be debrided and then allowed to granulate. Systemic antibiosis may be discontinued once a clean granulation bed has formed. Generally a 50:50 mix of a hydrophilic gel and silver sulfadiazine cream is applied daily after cleaning. Alternatively, medical grade Manuka honey may be used topically.

A special case is tail autotomy, where a natural defence mecha-

nism means the tail will almost always heal (and partially regrow) with no clinical intervention. Indeed, clinical intervention may well reduce the ability to regrow, therefore the remaining stump of tail should be left alone and not bathed. Systemic antibiosis and anti-inflammatories are also unnecessary.

Dysecdysis

Reptiles shed skin periodically as they grow; generally, the more rapidly they are growing, the more frequently they shed. Snakes and lizards shed differently, with snakes usually shedding the whole skin in one piece and lizards shedding in a more piecemeal fashion. This process may not complete, resulting in retained skin over particular parts of the body, such as inside the eyes (in snakes and leopard geckos) (*Figure 3*) or feet (*Figure 4*). Leopard geckos appear commonly affected, partly because of the complexity of their eyes, with skin shedding from inside the eyelids. These shedding issues are generally linked to inappropriate humidity, temperature and UV provision

In terms of treatment, underlying factors need to be corrected. The retained skin should not be pulled off as this may result in damage to underlying tissues, especially eyes and feet (*Figures 3* and *4*). Instead, the animal should be bathed daily in warm water and the retained skin gently bathed and allowed to come away bit-by-bit. In some cases patience is required, as the retained skin will not come away until the next shed.

Several factors may affect the ability to shed properly:

- Systemic illness, especially dehydration. Any systemic illness will affect the ability to adequately shed. Shedding involves the production of an entire new skin and the old skin is cast off by means of secretion of fluid between the new skin and old. Dehydration will therefore affect formation of the 'shedding fluid'.
- Malnutrition and parasitism – failure to adequately intake and absorb sufficient dietary protein will impact the ability to form new skin.
- Husbandry
  - Temperatures and method of heating: inadequate temperature ranges (especially where too low) will affect the metabolic rate and the ability to form the new skin and cast off the old. In the author's experience, retained shed on the feet of Leopard geckos is common and particularly associated with the use of heat mats on the floor of the vivarium. This appears to overheat and dry the skin of the feet, resulting in dysecdysis. Instead, heat mats should be positioned on the wall of the vivarium so warming is achieved via heat radiation rather than direct contact.
  - Humidity: low humidity is particularly associated with dysecdysis, owing to the interference with production of shedding fluid. This is a particular factor in dysecdysis of Leopard gecko eyes; while this species is a desert species living in a generally low humidity environment, it spends a lot of time under rocks in high humidity. As a result, a clean high humidity chamber filled with damp moss should be provided. This should be placed in the mid-part of the temperature range with the animal able to enter and spend increased time in high humidity when shedding. For snakes, vivarium humidity may be slightly increased (or additional bathing provided) when shedding is imminent (noted by the skin becoming blue-grey and dull as it separates).
  - Ultraviolet light: research in Leopard geckos has shown that over-exposure to ultraviolet light will result in increased shedding frequency and, likely, an increased probability of dysecdysis. This species is crepuscular and it has been shown that prolonged use of ultraviolet does not result in higher plasma calcium or vitamin D3 levels, so it is advised that Leopard geckos receive 2 hours of ultraviolet light both morning and evening. This should reduce shedding frequency (Gould et al, 2018).

Figure 3. Retained shed on the inside of the eyelids in this Leopard gecko has resulted in irritation and secondary infection resulting in this accumulation of skin and purulent material in the conjunctival sac and over the eye ('eye cap').

Figure 4. Dysecdysis in a Leopard gecko. The shed is incomplete, so the retained skin can be seen as grey and much paler than the new skin. Note the retained skin on the hind feet – this must be treated with care as rough handling and pulling of the skin can result in loss of toes. Similarly, if untreated, the retained skin will contract, causing loss of toes via loss of circulation.

As stated above, these factors need addressing in order to prevent problems that will worsen with each shed.

Blistered skin

Skin blisters (formation of small fluid-filled cavities in the skin) are common in snakes (*Figure 5*), but relatively rare in lizards.

While not a true blister (but often presented as such), the most

Figure 5. Multiple small blisters on the skin of young corn snake. Cytology revealed a yeast infection. The animal was part of a large group in a pet shop, where husbandry conditions were also sub-optimal.

Figure 6. Crusting of the skin from a yeast infection secondary to physical trauma in a Bearded dragon

Figure 7. Heat mat burns on the ventral skin of a Leopard gecko.

Figure 8. Overhead heater burns on the skin of a chameleon. In both cases topical treatment with iodine and barrier cream alongside correction of environmental temperatures worked well

common presentation in lizards is the formation of subcutaneous fluid-filled sacs in the axillae of Leopard geckos. These are usually bilateral and rarely appear linked with any other clinical signs. Cytology usually shows these to be acellular and underlying causes are unknown. They can usually be left and will resolve in time.

In snakes, skin blistering is much more common and there are a number of differential diagnoses (*Appendix 1*). Aside from a full clinical examination and history and husbandry review, the most useful diagnostic test initially is aspiration of fluid from blisters for cytology and bacteriology (both aerobic and anaerobic) plus mycological culture (if indicated by cytology). If this is unrewarding, full thickness skin biopsies are indicated for histopathology and culture.

Ulcerated/crusted skin

Crusting of the skin will often occur secondary to skin ulceration or physical trauma (*Figure 6*). This category should also be considered together with the previous section on skin blistering, as ruptured skin blisters will present as ulceration and crusted lesions. Clinical history is useful in finding out if skin blisters have been noted earlier in disease.

When investigating these lesions it is important to not sample superficial crusts as these will often yield environmental organisms or secondary/ tertiary invaders. Instead crusts should be removed and underlying tissues sampled for cytology/ histopathology and bacterial and/or fungal sampling.

Colour changes

Skin colour changes may be seen as generalised or localised changes, and have multiple differential diagnoses.

Generalised changes

- Brighter, more vivid colours may be seen after a shed in snakes, and especially in chameleons showing heightened emotional state. This is normally males entering a breeding condition and therefore a sign of health, but can be a sign of stress in males kept within sight of other male chameleons. In Bearded dragons, dominant males will show beard (the skin under the neck) blackening (often accompanied by aggressive behaviours and head bobbing). In all-female colonies, dominant females may show this too. Similarly, subordinate animals will lose this black beard and may become a brighter yellow/orange colour. However, a black beard can also be a colour change in an unwell or stressed Bearded dragon, which emphasises the need to combine skin signs with results from the clinical examination and history.
- Dull skin colour in snakes usually shows that they are entering shed, especially if the skin (including over the eyes) shows a grey-blue tinge. May be seen in some lizards, such as Leopard geckos.
- Generalised skin blackening carries a very poor prognosis as it shows peripheral circulatory shutdown (reptile skin colour, caused by blood flow through different 'colour cells'). If accompanied by collapse and lack of responsiveness, the prognosis is usually hopeless.
- Reddening/erythema/petechiation in snakes may indicate

KEY POINTS

- To understand the role of dermal signs as markers of underlying disease or husbandry issues in these species.
- To have a basic approach to investigating dermal lesions in these species.
- To have an understanding of diagnostic tests relevant to different clinical signs.

septicaemia or inflammation (such as in generalised skin burns, *Figures 7* and *8*). Care should be taken in Boa constrictors where there may be a normal rosy hue to ventral and lateral scales.

Localised

Focal lesions may be single or multiple and of varying significance and activity. If the animal is well, it may be worth observing the lesion for a period in order to assess progression before deciding to investigate. The most useful primary test is skin biopsy – further biopsy for bacterial/fungal culture may be needed depending on initial results.

Localised skin blackening is often seen following irritant subcutaneous injections or venepuncture, especially in chameleons. It is always worth advising owners of this before performing such techniques.

Masses

Dermal masses are common in snakes and lizards. Differential diagnoses (*Appendix 2*) are similar to those seen in more 'routine' veterinary species and approaches are similar too.

Neoplasia

Generally seen in older animals though some may be seen in younger animal (such as carcinomas, *Figure 9* and *10*) and it must also be remembered that some reptiles, eg chameleons, have relatively short lifespans. Tumours may be single or multiple. In general, malignancy is more common in reptile tumours than would be expected in pet mammal species. These masses tend to spread locally rather than metastasise (*Figure 9*), though this should be assessed in each individual case. One syndrome seen more commonly in recent years is that of carcinoma in chameleons and Bearded dragons (*Figure 10*). These are usually multiple and will often recur locally or at different dermal sites after excision. Prognosis is guarded but the masses are slow-growing. In cases where neoplasias occur in different sites simultaneously, there is suspicion these may be viral-linked, although this is unproven. In appearance they resemble granulomas or papillomas, emphasising the need to biopsy in these cases. Subcutaneous lipomas are common in corn snakes and may be diagnosed on appearance and cytology. These normally respond well to dietary management. However, a range of other tumours are also found, such as sarcomas in snakes and melanomas in Bearded dragons, so biopsy of masses is always recommended. Biopsy techniques are similar to those used in small animal medicine, although reptile tumours appear to be poorly exfoliative in the author's experience, making fine-needle aspirates less useful than wedge or excision biopsy.

Figure 9. Carcinoma on the eyelid of a Bearded dragon- this is a predilection site for this tumour in this species.

Figure 10. Multiple carcinomas on the skin of this female chameleon, containing discharge.

Granulomas and abscesses

Bacterial, fungal and (rarely) parasitic granulomas are all seen in reptiles. These are usually single but there may be multiple depending on the underlying causes (injury, skin penetration, parasitic larval spread). Diagnosis is by means of biopsy and therapy generally involves excision. However, in some more abscessated cases, the lesion may be opened and pus removed by curettage (reptile pus is solid); the abscess may then be allowed to heal by second intention. One important differential diagnosis for granuloma formation is mycobacteriosis. As this carries a poor prognosis and is also zoonotic, diagnostic sampling is recommended in all granuloma cases and acid fast staining requested in cytological examination.

True cysts are extremely unusual but may be diagnosed by appearance and analysis of aspirated fluid.

Conclusions

Skin disease is common in snakes and lizards, and can be approached successfully in most cases. However, a holistic approach to the animal and its husbandry and environment is essential. Focussing solely on the skin lesions will mean that vital underlying causes are not identified and corrected. CA

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ologic effects of short duration ultraviolet B radiation exposure in leopard geckos (*Eublepharis macularius*). J Herpetol Med Surg. 2018;*28*(1–2):34–39.
Hedley J. BSAVA Small Animal Formulary (11th edn). Part B; Exotic Pets. BSAVA, Gloucester, UK, 2023.

Further reading

As the approach to dermatological disease requires a good understanding of the entire reptile and its environment/ husbandry, the reader is directed to whole texts rather than specific dermatological texts/chapters:

Divers SJ, Stahl SJ. Mader's Reptile and Amphibian Medicine and Surgery (3rd edn). St Louis, MO; Elsevier, 2019
Doneley R, Monks D, Johnson R, Carmel B. Reptile Medicine and Surgery in Clinical Practice. Chichester, UK; Wiley Blackwell, 2018
Girling SJ, Raiti P. BSAVA Manual of Reptiles (3rd edn). Gloucester, UK; BSAVA, 2019.

Appendix 1. Common differential diagnoses for skin blistering in snakes

Disease	Special features Examination and history	Diagnostic tests	Prognosis	Treatment
Thermal burns (*Figures 7* and *8*)	Often associated with low grade chronic burns, although acute burns may also be seen. Vivarium temperature ranges may be low meaning the snake is driven to spend too much time close to the heat source. Lesion distribution will be associated with position of the heat source (ventral body for a heat mat; lateral body if coiling round a heat source/cage; dorsal body if overhead source). Blistering is usually transient, with progression to crusting and ulceration more common	History, appearance and absence of other causes. Bacteriology of aspirates indicated as secondary infection will occur	Good, if underlying causes are corrected and lesions are not too deep	Correction of vivarium temperatures and better protection of heat sources to prevent direct contact. Antibiosis where indicated. Topical cleaning with iodine-based cleaners and barrier creams as needed. Analgesia may be required especially in the short term. Where extensive, burns may require hospitalisation to correct fluid and protein losses
'Blister disease' aka vesicular dermatitis or scale rot (*Figure 11*)	This is a particular form of bacterial infection associated with poor environmental conditions, especially wet dirty substrate and high humidity. It is more common in natricine snakes. Lesions tend to be on the ventral body, although they may spread to other parts	History, appearance and bacteriological sampling - a range of bacteria may be involved as secondary invaders, although *Pseudomonas* spp appear most common in the author's opinion	Good, if early and mild lesions. Extensive deep lesions are associated with a more guarded prognosis	Correction of environmental factors. Systemic antibiosis based on culture/sensitivity Topical iodine preparations and barrier creams If the animal is systemically ill, it may require fluids and support feeding
Other bacterial infections	Blisters associated with bacterial infection may be found anywhere on the body and can be secondary to injury, parasitism, and/ or environmental factors	History, examination and cytology/ culture of lesions	Depends on causes and extent/depth of infection	Correction of underlying causes. Superficial lesions may be treated topically. Deeper lesions will require systemic antibiosis
Parasitic infection	Larval migration of various nematode infections may occur via the skin; larvae may enter from the environment; or migrate from hatched larvae in the skin. If the former, lesions are usually ventral; if the latter, lesions may be anywhere on the body. Affected animals are usually recently imported or have been recently sold via a dealer meaning this is now much less commonly seen now	History, clinical appearance, and finding of larvae on cytology of lesion aspirates. Faecal parasitology is useful for identifying nematode species, although false negative results may be obtained depending on stage of disease and nematode breeding cycle	Good as long as a mild parasite burden and no other systemic disease or debilitation	Avermectins or benzimidazoles. Do not use avermectins in indigo snakes or skinks (or chelonia)
Fungal infection (*Figure 5*)	See other bacterial infections. Secondary fungal infection may also occur as an opportunistic infection. An exception, as a primary pathogen, is *Ophidiomyces ophiodiicola* which has been recorded in wild Grass snakes in the UK	History, examination and cytology/culture	Depends on causes and extent/depth of infection	Correction of underlying causes. Superficial lesions may be treated topically (iodine-based cleaners). Deeper lesions will require systemic anti-fungals (itraconazole/ voriconazole; it is generally suggested that voriconazole is more effective)
Secondary to systemic disease	Systemic disease or parasitism resulting in hypoproteinaemia/hypoalbuminaemia can, potentially result in subcutaneous fluid accumulation though these tend to be large lesions as opposed to smaller blisters. However, this should be considered where such lesions are seen and there is evidence of systemic disease	Clinical examination, history, blood sampling, analysis of fluid from lesions (identification of a transudate)	Guarded	Treatment of underlying disease

Appendix 2. Common differential diagnoses for skin ulceration and crusting in snakes and lizards

Disease	Specific species affected?	Special features Examination and history	Diagnostic tests	Prognosis	Treatment
Thermal burns (*Figures 7* and *8*)	All	Normally associated with low grade chronic burns, although acute burns may also be seen. Vivarium temperature ranges may be low meaning the snake is driven to spend too much time close to the heat source. Lesion distribution will be associated with position of the heat source (ventral body for a heat mat; lateral body if coiling round a heat source/ cage; dorsal body if overhead source). May be preceded by skin blistering	History, appearance and absence of other causes. Bacteriology of aspirates indicated as secondary infection will occur	Good, if underlying causes are corrected and lesions are not too deep	Correction of vivarium temperatures and better protection of heat sources to prevent direct contact. Antibiosis where indicated. Topical cleaning with iodine-based cleaners and barrier creams as needed. Analgesia may be required especially in the short term. Where extensive, burns may require hospitalisation to correct fluid and protein losses
Physical trauma (*Figure 6*)	All	Granulation of superficial wounds or persistent skin irritation (for example, secondary to mite infestation) may result in irritation and ulceration	History and clinical examination. Bacteriology of underlying tissue indicated as secondary infection will occur	Good if underlying causes corrected and lesions are not too deep	Correction of underlying issues. Antibiosis where indicated. Topical cleaning with iodine-based cleaners and application of barrier creams. Analgesia may also be required, especially in the short term
Bacterial infection	All	A range of secondary bacterial infections may be seen. Bacteria may be purely opportunistic invaders of damaged tissue, or may be more pathogenic especially if the reptile is debilitated, such as in cases of dermatophilosis	History, clinical examination; cytology/ histopathology and culture (aerobic/ anaerobic) of underlying tissues. In these cases it is important to confirm a cellular response to bacteria in order to determine significance of culture findings	Depends on which infection and on severity of underlying disease and lesions	Antibiosis based on culture/ sensitivity. Topical cleaning with iodine-based solutions and application of barrier creams. Correction of underlying factors and disease
Devriesiosis (*Figure 12*)	Uromastyx lizards	A particular bacterial infection that acts as a primary pathogen in this species. May be carried asymptomatically by Bearded dragons asymptomatically. Lesions characteristic with thick crusting around the mouth and cheilitis	Clinical appearance. Histopathology and culture of biopsied tissue	Variable depending on health status of lizard and depth of lesions	Ceftiofur
Fungal infection (*Figure 5*)	All	A range of secondary fungal infections may be seen. Most fungi appear to be purely opportunistic invaders of damaged tissue. An exception, as a primary pathogen, is *Ophidiomyces ophiodiicola* which has been recorded in wild Grass snakes	History; clinical examination; cytology / histopathology and fungal culture of underlying tissues. In these cases it is important to confirm a cellular response to fungi in order to determine significance of culture findings. Both bacterial and fungal infections appear visually similar – it is not possible to determine type of infection by lesion appearance	Depends on which infection and on severity of underlying disease and lesions	Topical cleaning (iodine-based solutions) and barrier creams for superficial infections. Systemic anti-fungals for deeper infections. Correction of underlying environmental factors and disease

Appendix 2. Common differential diagnoses for skin ulceration and crusting in snakes and lizards (Continued)					
Nanniziopsis 'Yellow fungus disease' (*Figure 14*)	Bearded dragons and iguanas	Typically presents as crusted lesions, although patches of colour change also possible. Lesions may be localised or generalised. *Nanniziopsis guarroi* appears to act as a primary pathogen in these species, although there is usually an element of immunosuppression, especially when disease is seen as a colony outbreak. Generally animals will be recently obtained or mixed with others. In severe disease, systemic spread may occur	Biopsy of lesions for histopathology and fungal culture	Guarded if dermal lesions only. Poor if systemic spread	Correction of underlying factors. Frequent (daily if possible) changing, cleaning and disinfection of the vivarium to reduce spore numbers. Topical cleaning with iodine-based solutions. Voriconazole or terbinafine orally. Therapy will likely take 3–9 months
Neoplasia	All	Tumours may present with hyperkeratinised surfaces. The underlying lesion may not always be a raised mass (such as in squamous cell carcinoma)	Biopsy	Variable, depending on the ability to fully resect	Surgical resection if possible. Otherwise, none

Appendix 3. Common differential diagnoses of localised skin colour change in snakes and lizards					
Disease	Specific species affected?	Special features: examination and history	Diagnostic tests	Prognosis	Treatment
Scarring	All	White/grey lesions may reflect post-trauma or infection scarring. Typically lesions appear fibrosed and are non-progressive	Clinical examination and history. If no other signs of illness then observe for lack of progression	Good	None
Infection	All, especially Bearded dragons	Distal limbs and tail (aka tail rot) may show colour change (usually a brown-red colour) showing underlying damage or necrosis. In the latter case the colour change may ascend if untreated- if the animal is well, it is worth marking the line of colour change and assessing if it is ascending	Clinical examination and history. If well and the lesion is not progressing, then mark and observe. If the lesion is progressing and/or the animal is not well treatment is warranted. Radiography can be useful to assess underlying causes, such as fractures or osteomyelitis	Depends on spread	If non-progressive and well, none. If spreading and/or unwell, then start systemic broad spectrum antibiosis (such as ceftazidime or trimethoprim-sulphonamide). If severe, stabilise the animal and consider amputation of affected tail/limb
Nanniziopsis (*Figure 13*)	Bearded dragon	May show as localised grey or yellow patches with no crusting. Usually multiple and progressive	Clinical examination and biopsy	Guarded	Correction of underlying factors. Frequent (daily if possible) changing, cleaning and disinfection of the vivarium to reduce spore numbers. Topical cleaning with iodine-based solutions. Voriconazole or terbinafine orally. Therapy will likely take 3–9 months
Neoplasia	All	Usually raised lesions or crusting but may present as pale coloured areas	Clinical examination and biopsy	Variable	Resection if possible
Dysecdysis (*Figure 15*)	All	May present as localised areas of dull grey skin-retained spectacles in snakes may appear blue	Clinical examination and history	Good	See above

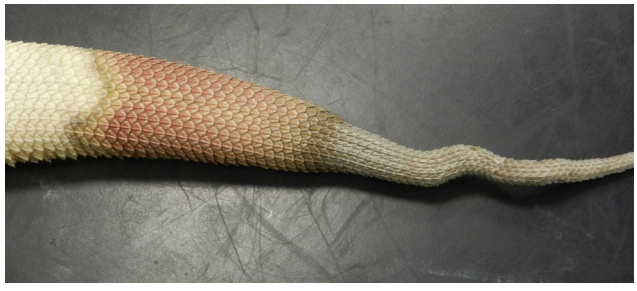

Figure 11. Tail rot in a bearded dragon. In this case the tail was amputated proximal to the line of infection

Figure 12. Devriesiosis in a Uromastyx lizard

Figure 13. Although called "yellow fungus disease" lesions are rarely yellow. In this case biopsy confirmed the presence of the causative fungus.flushing indicating tympanic membrane rupture

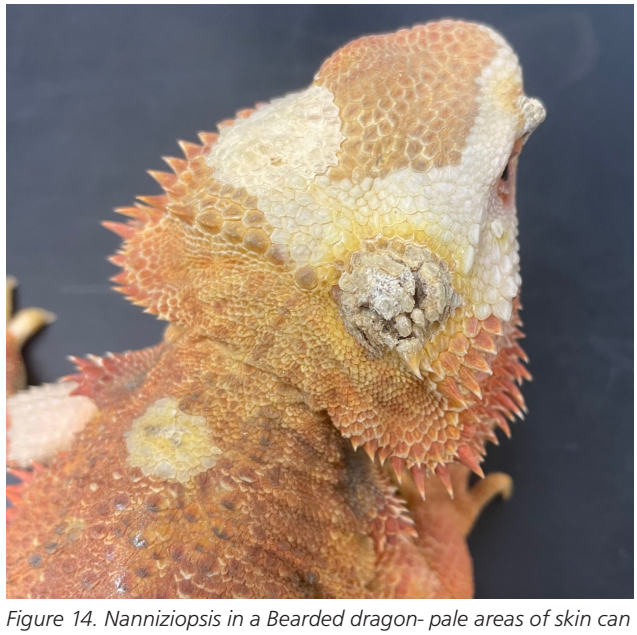

Figure 14. Nanniziopsis in a Bearded dragon- pale areas of skin can be seen as well as a crusting lesion on the dorsal head

Figure 15. Retained spectacle in a snake- note the pale colour to the spectacle and surrounding skin