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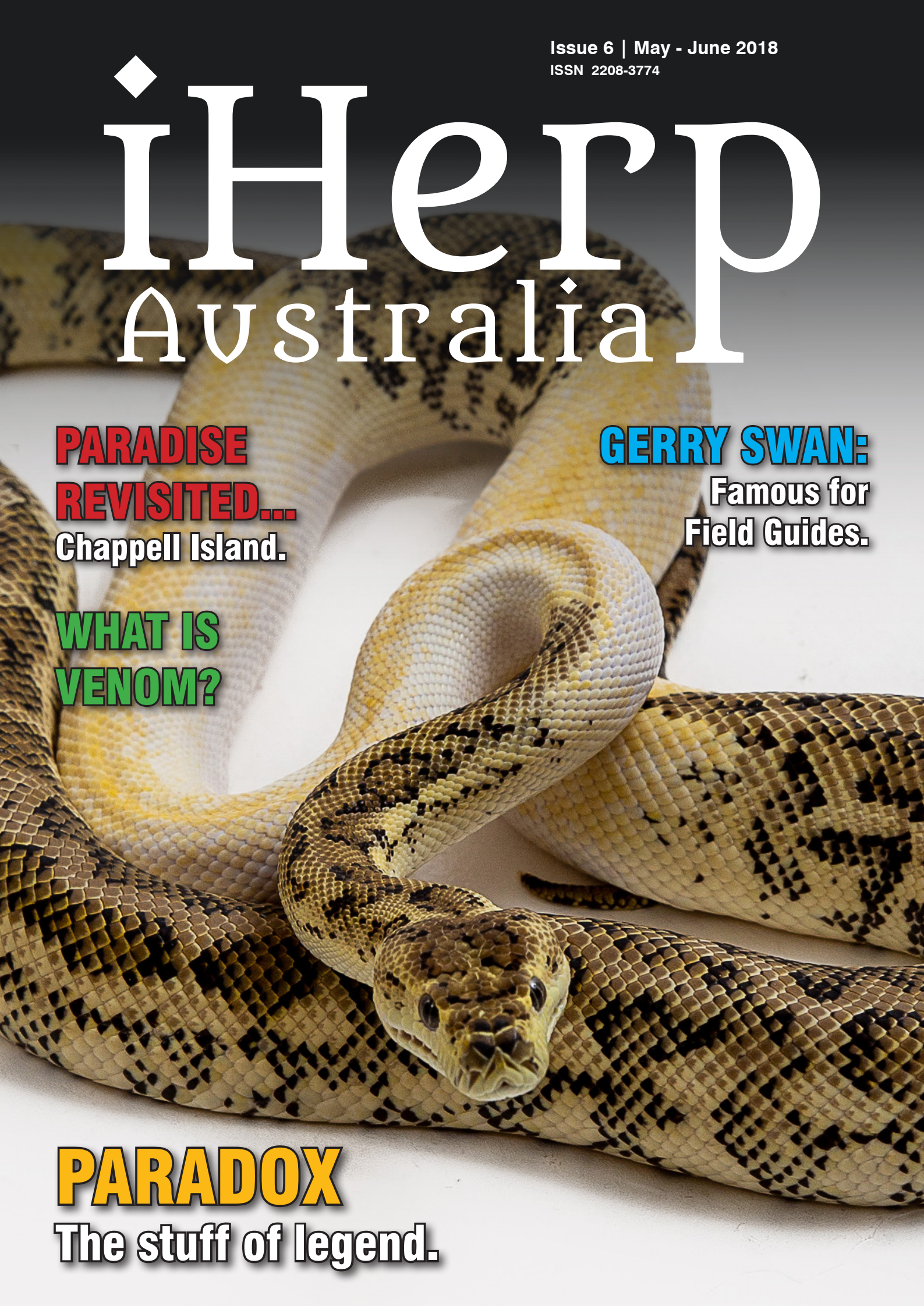
iHerp Australia



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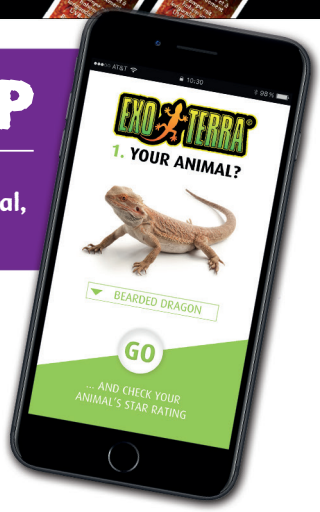

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The 'Wrangler' Writes...

Welcome to another issue of iHerp Australia, the reptile magazine that's free to read and download. We had a great time catching up with readers (and potential readers!) at recent expos in Melbourne and Brisbane, with Scott Owen and RepX delivering a great first-time show at the Brisbane Showgrounds.

As one breeding season ends, another looms large on the horizon, and already we are hearing of some amazing projects in the wings. So it's appropriate that our lead article in this issue concerns itself with a rare and very variable mutation that pops up spontaneously every now and then – the Paradox form. We have elicited contributions from breeders around the country, and the animals themselves are nothing short of stunning.

Then there is Michael Cermak's report on the famed black Tiger Snakes of Chappell Island, and Mitch Hodgson's examination of the importance of those buzz words 'behavioural enrichment' for captive herps. Think for a moment; can you define venom succinctly? You may change your mind after reading Bianca op den Brouw's fascinating piece. Plus Ben Dessen looks at how to set up a blue-tongue and more.

Now to a very special opportunity for herpers to take part in cutting-edge field work. Rom Whitaker's Agumbe research station in the south Indian rainforest is looking for volunteers to participate in the King Cobra radio-telemetry project, which will be ongoing for the next two years or so – turn to page 42 for further details of the adventure of a lifetime!

If you're after more, check out the weekly blogs on our website. iHerp Australia depends upon reaching as many herp enthusiasts as possible –so please don't forget to tell your friends. And drop us a line if there is something that you would particularly like to read more about.

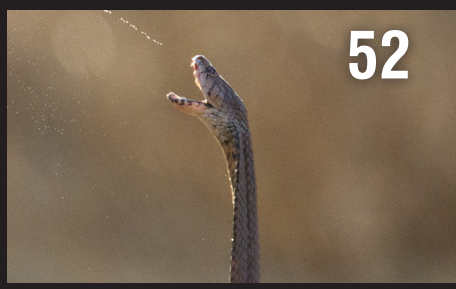
Happy Herping!

John McGrath

iHerp Australia

Issue 6 | May - June 2018

CONTENTS



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On the cover: chimera Paradox albino Coastal Carpet Python.
Photographed by Rochelle James.

PARADOX

The Stuff of Legend.

This Coastal Carpet Python exhibits clear delineation between leucistic and hypomelanistic phenotypes, and is therefore something of a classic genetic chimera. Image courtesy Deb & Wayne Larks.

Chimera (kī-mîr′ ə, kĭ-) **n.** A hybrid, female creature composed of part lion, part goat and part snake (Greek mythology); any fictitious monster consisting of disparate elements; a **harbinger of doom.**

The fearsome fire-breathing chimera of antiquity first appeared in Homer's Iliad, and apparently tormented the region of Lycia until it was ultimately dispatched with a lump of molten lead. The origin of this legend may be traced to a series of vents in a hillside in southern Turkey that to the present day emit burning plumes of methane, and were important landmarks for ancient sailors. Later, the title of chimera became applied to any fictitious animal composed of a mismatch of body parts. More recently, geneticists appropriated the term to describe a rare state in which a single organism contains cells of different genotypes, the expression of which may give rise to a heterogenous appearance. The most familiar example to anyone with an interest in herpetology is the 'Paradox' albino - but these stunning, highly-prized animals could hardly be described as monsters!

This article was inspired by the recent birth of a beautiful, brand new Paradox albino Spotted Python (*Antaresia maculosa*). iHerp Australia then canvassed some of the handful of breeders around the country who have been lucky enough to produce and work with Paradox snakes. The more research we did, the bigger the story grew, assuming almost epic proportions - as did our collection of incredible photos - but becoming increasingly fascinating in the process. Before introducing some of these amazing creatures, it is worth briefly examining the nature and inheritance of this condition, which is often shrouded in as much mystery as the original chimera of the Iliad!

'A Paradox albino exhibits areas of **melanin** deposition that simply **should not occur**.'

Albinism (derived from the Latin *albus* for 'white') is a simple recessive trait, found in all types of vertebrates, in which melanin (the black/brown pigment in skin and other tissues) is either not produced, or prevented from gaining access to the chromatophores. In mammals, which possess only a single type of pigment-bearing cell, this results in an all-white phenotype with pinkish-looking eyes. Reptiles, however, have additional chromatophores containing red and yellow pigments, as well as deposits of purine crystals that reflect light and may create an iridescent effect. Therefore, albino reptiles will not necessarily appear pure white, although they will not possess dark eyes.

A paradox is a contradiction that should not normally exist, and thus a Paradox albino is an albino animal that exhibits areas of melanin deposition that, under normal circumstances, simply should not occur. How does this happen? One explanation is that Paradox albinos are true genetic chimeras that result from the fusion of two different zygotes into one organism. So they contain both normal and albino genotypes, which create a 'patchwork' phenotype. Depending on which genotype creates the gonads, or sex organs, it is therefore possible that Paradox albinos will produce gametes containing either the recessive albino allele, or the 'normal' one. In other words, they are capable of producing albino or normal-looking progeny. Since it is due to the chance merging of two fertilised eggs, the Paradox condition created under these circumstances is not genetically heritable.

A small number of Paradox albino Darwin Carpet Pythons have been around for a few years here in Australia, and in late 2016 K Brothers Pythons (Troy and Denver Kuligowski) produced a fascinating YouTube video in association with Morelia Magic (Wayne and Deb Larks) that examined the issue of a pairing of two Paradox albino specimens. Similar numbers of albino and het hatchlings were produced, as may be expected from a conventional albino to het pairing, thereby supporting the notion that this form of Paradox is a chimera originating from the fusion of two eggs (you can view the video here: https://www.youtube.com/watch?v=jFNrnlk6ogM).

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However, some pairings tend to throw the odd Paradox on a regular basis, and breeders in this country and overseas (the latter principally working with Paradox albino Ball Pythons and sand boas) have noticed a degree of heritability. This may be explained by an alternative theory for the creation of a Paradox phenotype; spontaneous loss or gain of function caused by mutation of the albino/wild-type alleles. Sounds complicated, but let's look at a couple of simple examples. Take an embryo that is het for albino; if the wild-type allele is rendered non-functional (or deleted) in a single cell early in development, all cells derived from this cell will behave as albino, resulting in a patchy appearance. A similar effect could be produced in a homozygous albino by an albino allele that 'reverted' back to wild type (gain of function). If the gene concerned is inherently unstable, this would account for some heritablility. This is an example of a phenomenon that geneticists refer to as 'mosaicism', in which different genotypes exist in a single organism due to early mutation.

In some instances, it is possible to make an entirely plausible guess at the mechanism responsible for creating a Paradox. For example, some specimens appear to be almost 'half-and-half', with a clear demarcation between the two phenotypes involved, and these could quite reasonably be inferred to be the result of the fusion of two zygotes. An albino that has a very small patch consisting of a few dark scales, on the other hand, could logically be suspected of being a mosaic. However, although it would perhaps be more instructive to refer to 'chimera Paradox albinos' and 'mosaic Paradox albinos', in reality this is rarely practicable, and at best is based upon hypothesis.

There is another genetic anomaly which should also be included in this discussion, as 'pied' or 'piebald' animals can be very similar in appearance to Paradox albinos. Named after the Pied Piper of Hamelin, who, legend has it, was famous for dressing in multi-coloured clothing, and the humble magpie respectively, such specimens also exhibit patchy melanin deposition, but their genetic origin is quite different.

Piebaldism is often associated with leucism, a condition in which a total lack of pigment in the skin results in a snow-white phenotype which may also resemble an albino (although leucistic reptiles will also lack yellow and red pigments). Leucistic animals are distinguished from albinos by the fact that they have 'normal' (dark) eyes, since this trait only affects the skin. Like albinism, leucism is genetically heritable. However, some piebald animals have a black base colour, and others start off looking normal and then progressively lose colour over time (often stabilising when they reach maturity). So it seems there may be a number of types of piebaldism, which is also heritable, and has been demonstrated to behave as a simple recessive trait. Piebald Ball Pythons first appeared back in 1966, when a wild-caught specimen was exported from Africa to the US. Then in the 2012-2013 breeding season, three pied Stimson's Python hatchlings cropped up totally unexpectedly in Sydney, as the result of pairing normal-looking Queensland stock.

So how do you easily tell the difference between a Paradox albino, possessing a trait with little or no heritability and which is therefore arguably of limited value to morph makers, and a pied, which can be easily replicated? Although, in theory, Paradox albinos may have dark eyes (if the 'normal' genotype is expressed in this area), the likelihood of *both* eyes having pigment is relatively low. Pied animals (whether associated with leucism or not) will always exhibit pigmented eyes, so this provides a key phenotypical distinction in many instances.

'Pied animals can be very similar in appearance to Paradox albinos, but their **genetic origin** is **quite different**.'

There is no simple explanation for the Paradox form; there is much that we do not yet know, and this contributes to the ongoing mystique and allure to breeders. Now to some truly remarkable snakes. We will begin with the animal that provided the initial impetus for this article:

Right: *male Paradox Olive Python that could reasonably be suspected to be a mosaic. Image courtesy Deb & Wayne Larks.*

The ‘spotted albino Spotted’.

Vince Pintaudi runs Aussie Wildlife Displays in Melbourne. He also works at Amazing Amazon, and in his spare time still manages to squeeze in a couple of breeding projects.

In January 2017 I acquired a pair of 100% het albino Spotted Pythons from Toby Whitthoeft in South Australia. They were originally from different sources and were about four years old at the time. Toby had bred them once, and I believe he got one albino and six or seven possible hets in the clutch.

I started cooling the snakes in April, with a gradual reduction in heating from about 16 hours per day to around seven or eight, with no heating at night. Introductions commenced in May (as is standard practice with my *Antaresia* spp.) on a week-on, week-off basis, and plenty of courtship behaviour was evident in the second half of May and June. Ovulation was observed, and the female also frequently inverted her mid-section, in the typical fashion, as the time for laying approached.

The clutch consisted of nine eggs in all; the female had no problems throughout and was eating again almost immediately. The eggs were incubated over water at just over 30 degrees. I usually wait for the first egg to pip and then slit the rest – I’m pretty much old school in that respect. The first one to pip was a possible het, but the eggs were still quite turgid, making them difficult to slit, and there were a couple that I left alone. I did slit the egg containing the Paradox snake though, and I saw enough to have a fair idea what it was. I kept it to myself until the hatchling had emerged from the egg and I was absolutely sure!

In all the clutch consisted of two healthy albinos, another albino that died in the egg, four possible hets, and another possible het that hatched out but was badly kinked and died shortly afterwards. The Paradox snake is an incredibly vigorous animal. It is about four months old now and was a very good feeder right off the bat; it has shed three times already. I told Toby about it, and I don’t think he’s aware of anything like this happening in these lineages. The only other instance of a Paradox albino Spotted Python that I know of was bred by Snake Ranch a few years back.

I sold the hets, and the two albinos have gone to friends, but the Paradox (which is a female) isn’t going anywhere. I have no idea if the trait is heritable, but the plan is to mate it back to its father. I will wait a couple of years and get some size on it – I’m not in any rush and I’m not power feeding it. Meantime, I will pair the parents again for the coming season – who knows?

Image by Jack Hawkins.

A chimera Children's?

Dave Evans, of Clear Mountain Reptiles, weighs in with a spontaneous Paradox of his own!

A couple of seasons ago I was fortunate enough to produce a chimera Children's Python from a pairing of my double-het, T+ Marble animals. The animal appears to be a normal/T+ Marble chimera - I am calling it a chimera at the moment as that appears to best describe the appearance. I will be pairing it this coming season and hopefully after a successful breeding I will be able to describe it more confidently. It was quite an unexpected find as I was pipping the eggs. At first, when I saw two clearly different phenotypes in the egg, I thought I was dealing with twins. It was only on later inspection that I realised it was only one animal and I was then very eager to see it emerge from the egg!

I have also had a few Paradox albino carpets in my collection over the years, with a couple still remain-

ing. The first one was my original albino Darwin female which had one jet black scale - not very dramatic I know, but still a Paradox nonetheless! I paired her one year with a male Zebra and produced a healthy clutch of 100% hets. One of those male hets has produced two Paradox animals in two separate clutches. One of these has about three black scales clustered together and the other has approximately 5-6 scales that are a smudgy-brown colour. A different male het was sold to a friend and produced three Paradoxes in one clutch (see comments from Neville Reibelt), all of which exhibit quite a lot of black pigment compared to my animals. I have been able to acquire one of these snakes and will be pairing it back to one of the hets from my original albino female.

Dave, why do you think that some animals seem more likely to throw the odd Paradox?

I think if you are talking about chimeras then lines which tend to produce more twins will just simply give you a higher chance of getting fused eggs, but if you are talking about a leaky gene, or spontaneous gain of function, or whatever else is causing it, then I would imagine that some animals are just more predisposed to develop the condition. Like if you have a family history of breast cancer, or heart disease etc. - it's not a genetic trait with a straight mode of inheritance, but its lurking in the background somewhere.

Another interesting thing I've noticed with most of the Paradox albino Darwins and the Paradox T+ Children's Python is that the pigment they do tend to have (or gain) is often totally jet black and frequently in greater quantity than you would expect if that particular patch of the animal was normally pigmented. There are obviously some that do display the 'normal' colouration in the areas where they are pigmented, but I would almost put these in a different class. I think this goes to show that there are several types of Paradox and they produce different visual appearances. Chimeras are generally obvious, with fairly clear differences between one animal and the next, but the albino Darwins, T+ Children's Python and the Paradox albino Spotted Python produced by Snake Ranch are all something else. Anyway I could ramble on about this for ages and still not actually figure anything out!

'It's not a **genetic trait** with a straight mode of inheritance, but it's **lurking in the background** somewhere.'

The leucistic Burmese Python they have at Australia Zoo is a good example of what I believe to be a 'spontaneous gain of function'-type paradox.

Left: *suspected chimera Paradox T+ Marble/normal Children's Python.*
Above: *Paradox T+ albino Children's Python. Images by Ben Thompson..*

Paradox albino carpet python. Image by Ben Thompson.

The best Christmas present!

Neville Reibelt has been refining some beautiful lines of pythons for two decades, but got an unexpected surprise a couple of years back.

The season before last, I was pipping a clutch from one of my albino Darwins, when I came across an animal that looked like it had shit on itself inside the egg. Just then, a mate rang and I told him about it.

"Don't do any more until I get there!" he said – obviously he had guessed what it might be. When he arrived we started going through the other eggs. With mounting excitement we found a second and then a third Paradox; three in the one clutch. Christmas is my favourite time of year as you never know what you are going to get when all the eggs start hatching. Occasionally something different crops up, and that's what really keeps me going.

The female that produced the clutch is a long-time breeder that hatched in November 2007. She doesn't lay every year, and didn't have any eggs the year before the Paradox animals were produced, or the year after (which was last year), but has had a lot of progeny and never before thrown anything like them. She was originally from Simon Stone's line, which is interesting, as Simon did produce at least one Paradox albino Darwin. When I saw it in about 2007, it was already an adult, and had a few black patches. The other interesting thing is that every other clutch my female has produced has comprised a total of 19-21 eggs, whereas the one that included the Paradox animals was 30. I keep careful records of my animals and there was no difference in her weight.

The year the Paradox animals came along was the first time I had paired my female with a het albino Zebra male from Dave Evans. I believe the line came from down south somewhere – there is talk of someone down there consistently producing Paradox animals from a couple of het albinos. Unfortunately, I subsequently lost the male with myeloid leukaemia. When I took it to the vet, he said it was the third snake he had seen with the condition within a week.

My three Paradox snakes were all males. All had nice markings, and they seemed to develop more black as they aged. I sold the two that had smaller blotches and kept one which is very heavily marked. I've had a couple of serious offers for it, but I figured there are so few around I would keep one. To be honest, I didn't think much of the Paradoxes at first, but they have grown on me, particularly with the evolution of the markings.

'I didn't think much of the Paradoxes at first, but they have grown on me....'

I intend to put mine (which is now 18 months old) back over his mum next season. He will be the only male I use with her, and I will also put him with a couple of other female Darwins. If the mother lays, I will hold back a couple of pairs of the progeny – even if there are no visual markers – just to see if they are some sort of 'hets', with a genetic predisposition to producing Paradox animals.

Right (slide show): *the markings have evolved considerably over time (more than one snake shown). Images by Neville Reibelt.*

Reverse Paradox and lethal leucistic….

Wayne and **Deb Larks** from Morelia Magic have been at the forefront of python morph breeding in Australia for many years now, but their enthusiasm for new projects remains infectious.

I think we can help out a little with the history that Neville was talking about. Simon Stone's original albino Paradox Darwin was called 'Destiny' and was the result of a het to het pairing. Coincidentally, I believe that when Destiny hatched, Simon (like Neville later on) also initially thought that the markings were caused by faeces present in the egg.

I don't think Destiny herself produced any more Paradoxes, but when Simon retired, he advertised his Paradox project for sale, which included a couple of Paradox animals and a bunch of related snakes. Deb still has the advert. Simon may have held on to Destiny, but some of the Paradox animals around now can be traced back to one of her siblings (another Paradox) from a different clutch.

Our Paradox albino Darwins are totally different to Simon's, and four or five have cropped up at random in the same line. As mentioned earlier in this article, a few years back, along with the

Kuligowski brothers and Justin Julander, we looked at the results of a pairing of two Paradox animals in a couple of YouTube videos. Exactly the same number of albinos and hets were produced, suggesting that this Paradox is in fact a chimera. Last year we also acquired some hets that originally belonged to Damian Hyde and produced Paradox and 'reverse Paradox' three seasons in a row. We have not yet bred any Paradox Darwins ourselves, but recently hatched a couple of 'reverse Paradox' animals – with small white patches where there would otherwise be normal colouration. Some people also refer to these as 'Calicos'.

Although there are not many Paradox albino Darwins around, last year we know of seven that were hatched out; three each in two separate clutches and one from a first-time breeder.

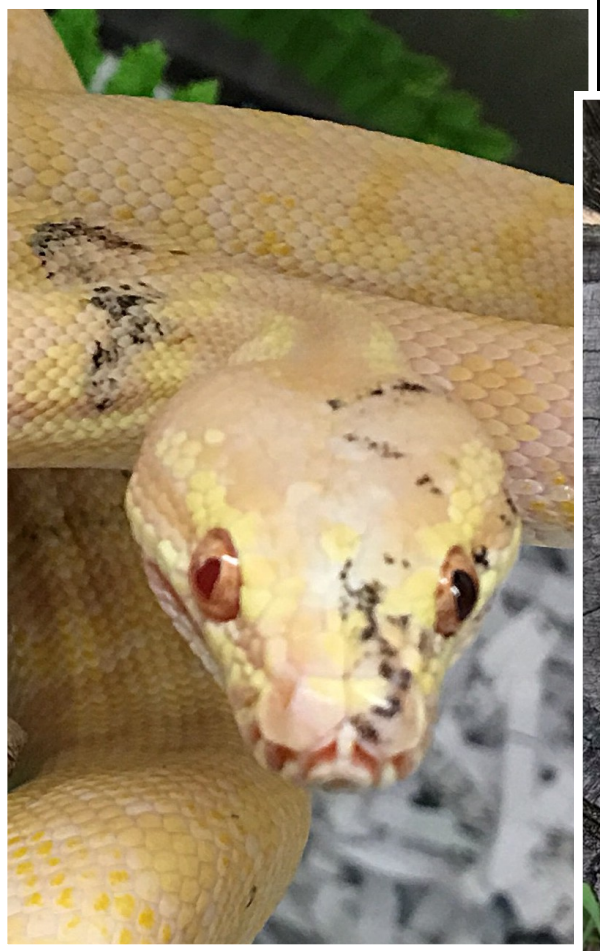
There is also a line of axanthic Coastal Carpet Pythons which will occasionally pop out a Paradox. We have bred one, and we know of a couple of other people who have a total of four or five.

Then there is the chimera that we hatched from a Jag to Jag pairing. It is part 'super' form, which is lethal leucistic, meaning that it is not quite right and shows signs of 'neuro' – when it came out of the egg it could hardly breathe. It is definitely a chimera, as it clearly can be seen to contain parts from two different animals (rather than a sprinkling of different colours or pattern). We will try to breed from it, but it may not be very productive; it is basically a pet.

We also have a Paradox albino Olive Python, which is one of only two randomly produced in Australia. It is currently 18 months old, and is unusual in that it has a dark tongue.

'We recently hatched a couple of 'reverse Paradox' animals….'

Left: *Paradox albino Darwin Carpet Python.*
Above right: *small 'reverse Paradox' animal.*
Right: *this Paradox albino Olive Python is unusual in that it has a dark tongue.*
All images courtesy Deb & Wayne Larks.



Above: *the Paradox form can conceivably result in any combination of eye colours.*
Right: *the part leucistic chimera, along with a normal albino phenotype.*
Below: *more from the impressive collection at 'Morelia Magic' All images courtesy Deb & Wayne Larks.*

Paradox Ghost Zebra Jags, Caramel Jags and Sunglows!

NSW breeder, **Jarred Sharp**, is proving that the Paradox form can have some heritability.

I have produced Paradox animals from two separate lines. All have originated spontaneously, and were totally unexpected.

The first resulted from breeding a pair of Caramel Jags that were 100% het for albino. They were predominantly Jungle, with some Coastal, and would have been lucky to have 10% Darwin blood in them. Their clutch included a Paradox leucistic Jag, which was half white and half normal. It died after about two days; I didn't expect it to live because half its head was white, and so was the area where its lung would have been – a likely indicator of underlying problems.

I kept most of the rest of that clutch, and later paired a Caramel Jag back to one of its albino siblings. This produced what is often called a reverse Paradox animal (really just a Paradox that's more normal than albino, rather than the other way around).

There was also a female 'Sunglow' (or 'hypo albino' – which tend to be brighter, with more orange than normal albinos) in that same first clutch. She proved out to be a 'Superglow' and I paired her in the season just gone with a Zebra het albino which shared the same grandfather. There were two Paradox albinos in her clutch, and both were also Sunglow. I have kept one; he is very heavily patterned, with one black eye and one red.

My other form of Paradox popped out of an axanthic Coastal (from Wayne Larks' bloodline) to Jungle cross about two years ago. I remember thinking at the time; *that's not normal!* In the same clutch there were also Ghost Zebras. I paired one of these to a related animal this year and got two Paradox animals – one is a Ghost Zebra Jag and the other is a Caramel Jag. I will be keeping both of these. More Paradox specimens have been bred elsewhere from the same line.

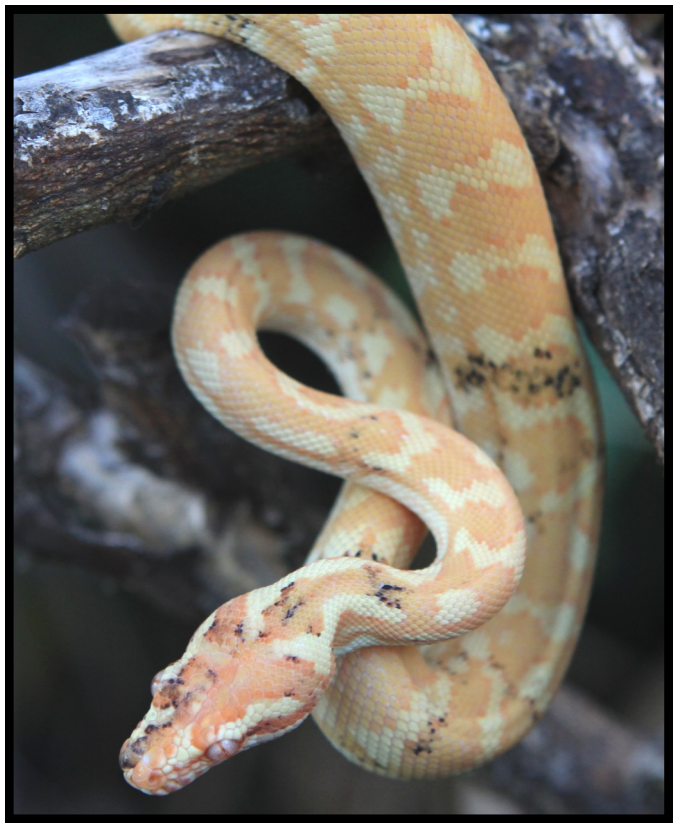
Above: *Paradox Ghost (hypo axanthic) animal. Images by Jarred Sharp.*

My best guess is that there is something in the bloodlines concerned, and hopefully eventually we will be able to refine this condition and can start to predict exactly what's going on. This coming season I will be crossing a reverse Paradox albino male back to his sister or mum. If we get higher proportions of Paradox from directly-related animals then we are going somewhere. The male concerned in a Caramel animal with albino patches. I tried to breed from him last year but he just was not up to it. It will be interesting because

'Hopefully we can refine the condition and start to **predict exactly** what's going on.'

right where his hemipenes are is a big patch of albino, so I will be very curious to see what he breeds as. I want to work out what he will produce before putting him over too many females – he could breed as a het or an albino. I'm also trying to remove as much Darwin blood as possible to determine whether the Paradox trait is tagging along with the Darwin genes.

I'm pretty sure that every Paradox animal I have ever produced has been a male, which is why I haven't kept all of them. My feeling at this stage is that the Paradox state needs to be present on both sides of the family tree in order to be expressed. All of the ones that I have produced have come from pairings that are closely related. There is a lot of work still to be done, but the next couple of years will be very interesting.



Above: *Paradox Sunglow (hypo albino)..*
Below: *reverse Paradox (Caramel with albino patches).*
Right (slide show): *Caramel Paradox Jag (Caramel Jag with axanthic patches) and Paradox Ghost Zebra Jag believed to be the only one in the world.*
Images by Jarred Sharp.

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An Ordinary-looking Pair....

Tim Mensforth, of iPetz, was breeding reptiles on a commercial scale at a time when the hobby was essentially in its infancy.

About eight years ago, we paired up a couple of pretty ordinary-looking Darwin Carpet Pythons. They were both about four or five feet long, but I can't tell you where they came from. Anyway, the clutch included one Paradox albino and two Calicos (which had a faded-out normal Darwin pattern with white spots)

'Everyone likes to think that they will be the ones to crack something new!'

The next year the same pairing produced more Calicos, so we thought we were really on to something. Unfortunately, then we lost the adults. We put a lot of work into the animals; both the Paradox and the Calicos were not right – like many other unusual mutations – and had problems for years with respiratory infections.

Finally after about three years we started mating the Paradox male, but then we had to stop cooling the snakes because they all got respiratory trouble again. Today, I think we may still have one of the snakes left in the collection. In retrospect, we probably should have sold them. I'm old enough to know better, but I guess it's exciting and a challenge - everyone likes to think that they will be the ones to crack something new!

1. *some unusual-looking hatchlings.*
2. *Paradox albino Darwin Carpet Python.*
3. *The Calicos had a faded-out normal appearance with white spots.*
4. *Calico and Paradox albino Darwin Carpet Pythons mating.*

Images courtesy Tim Mensforth.

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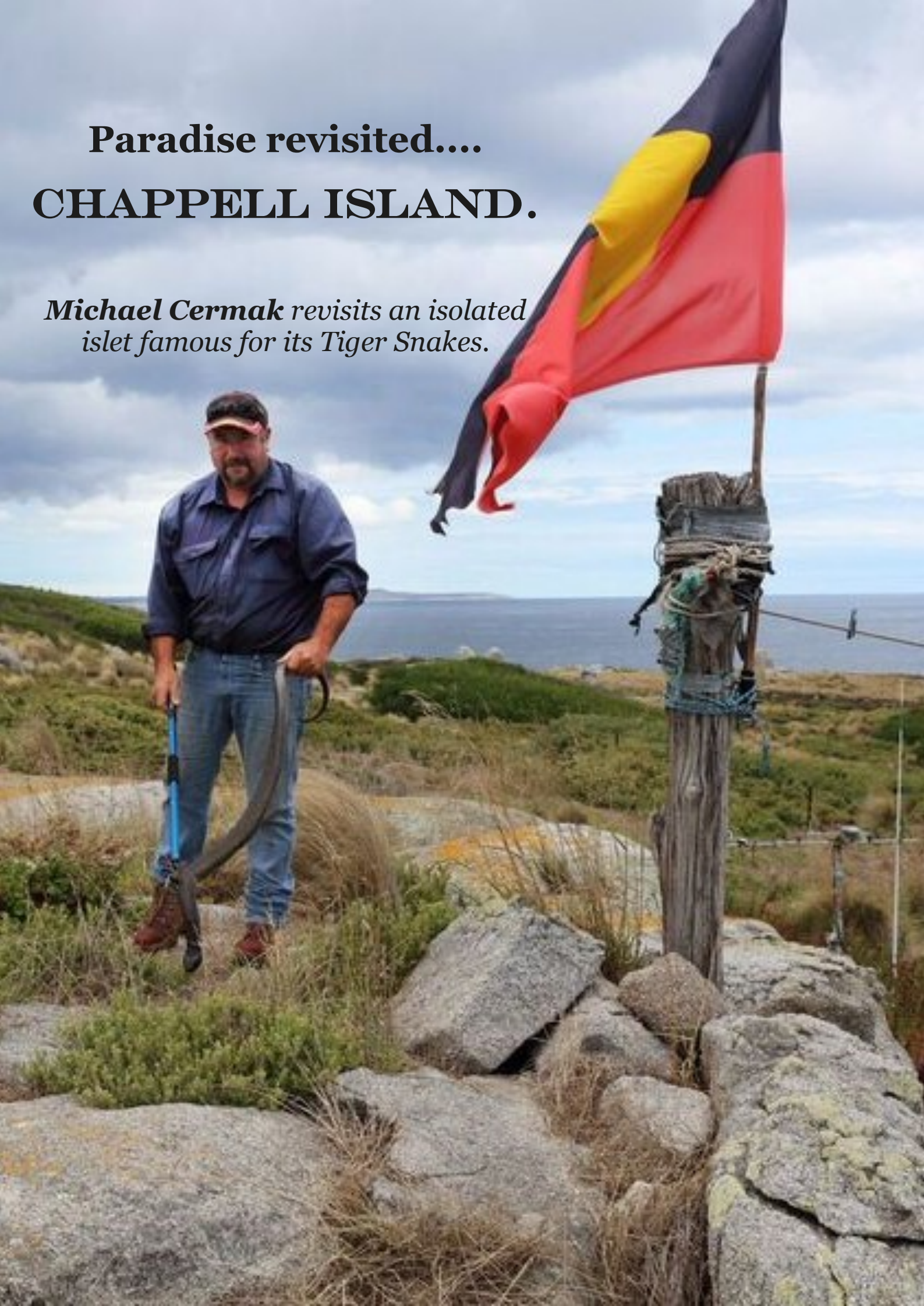

Paradise revisited....

CHAPPELL ISLAND.

Michael Cermak *revisits an isolated islet famous for its Tiger Snakes.*

After walking around the island twice, getting tangled up in barilla (the local salt-tolerant vegetation), and being severely wind-blown, I was pretty buggered by the end of the day. This was in November last year, and I really thought it would be my last trip to Chappell Island. But recently an opportunity arose to visit the iconic island again, for the fifth time.

There have been a lot of changes since my first visit in 1984; perhaps the most significant being the ownership of the island. When European settlers arrived in the Furneaux Group of islands, north-east of Tasmania in Bass Strait, they utilised the island for sheep grazing and, along with the Aboriginal people, also for muttonbirding. After several deaths from Tiger Snake bites, muttonbirding ceased in 1975, but the sheep stayed on until Chappell Island was handed over to the Aboriginal community in 1995, along with three other islands in the group; Badger, Great Dog and Babel. The Aboriginal Land Council was formed that same year for the purpose of holding the land titles on behalf of the Aboriginal community and administering the Aboriginal Lands Act 1995. *Lungtalanana* (Clarke Island) was returned to the Aboriginal community in 2005 through the same legislative process, along with Cape Barren Island, which is managed by the Cape Barren Island community.

Naturally, the rangers working on these islands frequently come in contact with snakes and, being such isolated places, any need for medical help is a concern. Grahame and Ambrose are stationed intermittently on Chappell Island, which is literally moving with big Tiger Snakes. Although these snakes are unbelievably docile, a bite from this species would present a serious issue, especially considering that it takes four hours for a helicopter to reach the island. That is the reason why my friends Justin Kneebone and Chris Daly from Tas Reptilia were invited to Chappell Island, to organise a workshop on catching and handling snakes, including first aid. Justin and Chris are based in Hobart and they provide educational talks and displays throughout Tasmania. Apart from the two 'locals' (Grahame and Ambrose), rangers from the other islands also attended the workshop - we had a blast of a day. How did I fit in? Well, iHerp Australia magazine sponsored my trip in order to document this one-off event, and the Tasmanian Aboriginal Corporation guys kindly flew me from Launceston to the island with Frank Willebrand, the gun pilot of Flinders Island Air Charter.

Priority number one was to secure a couple of good-sized Tiger Snakes for the workshop. Nothing could be easier on Chappell Island. We landed on the airstrip at 10am and found at least ten good-looking tigers on the half-hour walk to

Far left (feature page): *one of the rangers learns how to handle a Tiger Snake.*
Left: *Chappell Island is part of the Furneaux Group, lying north-east of Tasmania and comprising just 323 hectares.*
Below: *Chappell Island ranger Ambrose with a muttonbird chick.*
All photos by Michael Cermak.

Main: *the dark colour of Chappell Island Tiger Snakes helps them to soak up the sun on cold mornings.*
Insert (above): *White's Skink (*Egernia whiteii*) is common on the island and represents an important foor resource for juvenile Tiger Snakes.*
Insert (right): *the workshop included training on catching, handling and first aid.*

the shed that would serve as the venue for the workshop. So that job was done. After the other guys had arrived by boat, Justin and Chris decided to hold the theoretical part of the workshop inside the shed, as it was quite hot and sunny outside; not ideal conditions for handling snakes. Ambrose and Grahame were familiar with Tiger Snakes and very enthusiastic to participate, but some of the other rangers needed a bit of encouragement to put their hands on the snakes. Chris and Justin dispelled some of the fallacies about snakes and pointed out facts such as snake's eyes look cloudy before sloughing - it's not that they're going blind. As most of the Tiger Snakes had ticks, the rangers were shown how to safely remove these parasites, as well as how to get the snakes in and out of hoop bags and how to use a hook and pinner effectively.

Then heavy clouds suddenly appeared in the sky and it was perfect timing to put the theory into practice outside. It didn't rain, so some of us set out to look for more snakes. As always, herping on Chappell Island is a bonanza! I remember in 1984 and 1986 a lot of the adult Tiger Snakes were dark brown and banded, however, in my last two visits I have only seen black specimens without markings. Chris desperately wanted to see a juvenile (they are quite rare) and he finally found one; a nicely banded specimen about 80cm in length. Unlike the adults this youngster had plenty of attitude.

Why are so few juveniles seen? They are having a hard time on the island and I would hate to guess what the survival rate is. Although there are mice and skinks present, generally speaking the food resources for small

‘Chappell Island is literally moving with big Tiger Snakes.’

snakes are meagre and the summer is short. Judging by the number of adults with stumpy tails, I suspect the gulls are attacking them, and of course if they happen to pick up a snake that is small enough, it goes straight down the gob. In the past there were also feral cats on the island, which contributed to predation on young snakes, but according to the rangers, after a successful trapping program there is only one left. In addition, Tiger Snakes are known to be cannibalistic, so the juveniles avoid the muttonbird rookeries where most of the adults reside, and instead mainly inhabit areas of grassy tussock and large shrubs, which serve as refuge when danger approaches. So, whilst the adult Tiger Snakes have no predators, the young ones are constantly under the pump.

Many of the adult snakes have scarred necks from ticks, which doesn’t add to their good looks, but they don’t seem to be infested to the point where they can not function. Apart from a small spring on the southern side, there is no permanent water on the island, so the snakes don’t have the opportunity to soak themselves to get rid of the ticks. No water means there are no frogs, and hence likewise there are no copperheads on Chappell Island. The Tiger Snakes feed largely on muttonbird chicks during the breeding season, but once the chicks are too big it’s the end of the feast. Rats and mice provide little supplement to the snake’s menu; it’s the fatty, oily and smelly chicks that constitute the main course. The window of opportunity only lasts about six weeks in the summer months before the chicks are too big for the snakes to swallow.

During the last ice age, the land bridge connecting Tasmania with the mainland allowed Tiger Snakes to move south. When the oceans rose, the Furneaux Group of islands was formed and the Tiger Snakes on these small islands became isolated. Chappell Island comprises only 323 hectares, and as previously mentioned is almost bereft of permanent water. These constraints were probably responsible for the early extinction of frogs and mammals, leaving only reptiles to survive. It is not clear when the muttonbirds colonised the island but it was a blessing for the snakes. Each year the birds return to the rookeries to raise their chicks and that means a banquet for the Tiger Snakes.

Incidentally, with my limited exposure to the wonderful islands in the Furneaux group, I always wondered what would be the minimum required size of an island to support a viable population of Tiger Snakes. Of course area is not the sole limiting factor, as the abundance and type of food resource, presence or absence of freshwater and predation all play an important role. Chappell Island seems pretty small to accommodate the estimated 1,414 (Schwaner and Sarre, 1985) Tiger Snakes that are in residence, but there are even smaller islands in the group inhabited by Tiger snakes. In decreasing size, with area measured in hectares, these are: Preservation Island 207.45; Forsyth Island 166.85; Little Green Island 86.62; Little Dog Island 83.01; Chalky Island 41.31; Cat Island 38.82; and Storehouse Island 19.8. Chappell Island Tiger Snakes are the largest of all the races, having only a single, saturating food source for the adults. Thanks go to Simon Fearn, Collection Officer with the Queen Victoria Museum and Art Gallery in Launceston, for providing me with this information.

This may be a Mecca for snake enthusiasts, but from an ecological point of view not everything is rosy. Since the removal of the sheep, Boxthorn (*Lycium ferocissimum)* has spread in some parts of the island and is creating a huge workload for the rangers involved in the eradication of this incredibly resilient, thorny bush, which is very hard to control and destroy. When cut off at the base, the roots must be poisoned and the branches burned, otherwise both will sprout again. Although progress was clearly visible compared to last year, further funding and other resources from the government would help to speed up the process. More hands on the ground and more machinery such as additional front-end loaders and weed mulchers would make a huge difference. The weed mulchers are on rubber tracks so they do not leave a large footprint on the fragile rookeries and grasslands.

Chappell Island is of great importance to the Aboriginal people, as for millennia (dating back at least 20,000 years) it formed an important part of their seasonal food-gathering cycles. It is therefore vitally important to preserve the ecological integrity of the island for future generations. The TAC and their employees take pride in the island's long and rich Aboriginal history, and strive to maintain its historical and cultural significance, as well as improving and facilitating access for the Aboriginal community. The rangers act as tour guides during community visits; they showcase their work and point out the sites of the old muttonbird sheds and places of relevance to Aboriginal heritage.

This is a very special place for me too; as a teenager I read Eric Worrell's book *Song of the Snake* and I knew then that one day I too would step foot on the island. I am grateful to the Aboriginal people of Tasmania for allowing me to visit their island for the fifth time and I wish them every success with future management and maintenance. Look after the *plantina* (the word for snake in *palawa kani* language).

Top left: *a landscape pockmarked by muttonbird burrows.*
Above (slide show): *Justin Kneebone holds two Tiger Snakes; a compulsory photo on each trip to the island. Some of the rangers needed a little encouragement to participate in the 'hands on' experience.*

Main: *Chris Daly, Justin Kneebone and Ambrose removing ticks from a Tiger Snake.*
Inset: *group photo at the end of the day.*

Gerry Swan: Famous for Field Guides!

Neville Burns talks to a man whose pre-eminent reptile field guides have got Australia covered.

‘I try to just let the animals do their thing, but of course there is a lot of difference between photographing a gecko and a snake, for example.’

Above: *Smooth Knob-tailed Gecko* **(Nephrurus levis).**
Inset: *Gerry is not fond of 'selfies' and it's not easy to obtain a good photograph of him!*
All images supplied by Gerry Swan.

Neville: Gerry, how long have you been involved in herpetology and how did you get started?

Gerry: It started when I noticed a whole bunch of skinks when I had to clean up an overgrown bank at the family home. I was probably about 12 years old. Then I found a green gecko when clambering through the bush. I guess I really got involved when we moved to Sydney in 1965 and I found a blue-tongue in the backyard of the house we purchased.

Neville: Where were you living up until then?

Gerry: Wellington, in New Zealand.

Neville: Were there people who encouraged and supported this initial passion or were you mainly on your own in your interest in reptiles?

Gerry: Mainly on my own in NZ. While my parents didn't actively encourage my interest they didn't discourage it either.

Neville: Was your interest a broad-based one or were there particular species that captivated you?

Gerry: It has always been a fairly broad-based one.

Neville: Being someone who liked reptiles it must have been exciting to come to Australia where there is such a wide range of species?

Gerry: It certainly was and it didn't take very long to come across the more common species of reptiles around Sydney.

Neville: Did you begin keeping reptiles and have you attained any academic qualifications?

Gerry: Yes I started to keep a few animals. In those days it was a matter of putting together your own cages - checking out council cleanups for cracked aquariums or ripping the guts out of discarded TVs, etc. Cages were in all shapes and sizes; pretty primitive by today's standards. Of course there were no books on reptile keeping at that time. No, I haven't attained any academic qualifications.

Neville: Did you gravitate to other people with a similar interest once you came here or did it take a while to find other people with the same passion?

Gerry: The only way to learn was to meet up with other people and talk with them. I found out about the AHS and quickly joined up. That exposed you to a range of reptile keepers, some good, some bad, but it was a very valuable learning experience.

Neville: When did you develop into a reptile photographer, or was this always part of your interest in herpetology?

'In those days you made your own cages from cracked aquariums or by ripping the guts out of discarded TVs.'

Gerry: It really wasn't until I was working on the NSW field guide that I got serious about photographing reptiles. However, my son Geoff was always a better photographer, so I used to get the animals and set them up while he photographed them. It didn't matter whether it was a Mulga Snake or a blue-tongue, he concentrated on the pic and I concentrated on the animal. As it happened, no one got bitten.

Neville: Obviously for publications that are based upon identification, the reptiles have to be photographed in such a way that their unique characteristics are clearly shown. Does this mean a lot of 'setting up' of the animals and have there been any that are particularly difficult to photograph?

Gerry: I try to keep set up to a minimum and just let the animals do their thing, but of course it depends on what you are trying to photograph. There is a lot of difference between photographing a gecko and a snake, for example. With digital cameras you don't have to worry about film and processing costs, so you just keep shooting. Dangerous elapids are difficult during the middle of a hot day.

Neville: Gerry, hopefully the fact that you have no academic qualifications and yet have gained such a sterling reputation as an authority will be an inspiration to others who have not gone down the academic path. How did you first get into publishing and what was your first effort in this aspect of herpetology?

'The endangered Ornamental Snake was the second most common snake we removed from the trench....'

Gerry: I think that things were a bit different in our day Neville. We were all field-oriented then and learned most of what we know by field observations, etc. These days you need to have a degree for starters. Mind you, I have seen a few graduates out in the field who were pretty useless when it came to finding or catching a reptile, or even finding their way around.

Allen Greer at the Australian Museum is to blame for getting me into publishing. It was back in the 1980s and we were talking about the lack of regional field guides. So I got started on the NSW field guide which first came out in 1990. The big publishers at the time were not interested and I finally had it published by Three Sisters Publications in the Blue Mountains.

Neville: How long were you publishing before you combined with Steve Wilson and how did this eventuate?

Gerry: I had already published four books and around 2001 or 2002 my publisher (New Holland) contacted me because they were keen to do a guide covering all the Australian reptiles. I told them it was too big a job for one person within their time frame and suggested Steve Wilson could be a good co-author. I knew Steve of course, and also that he was a recognised wildlife photographer. Photos would be a major part of any such book. So it all evolved from there.

Neville: How and when did you get involved in the gas line animal rescues and what are some of the species you have removed from the trenches?

Gerry: The pipeline work came about through Steve. I was doing a reptile survey out near Gunnedah when I got a phone call from Steve who was working on a pipeline in Queensland from Moranbah to Townsville. The work was too much for one person, so the construction company told Steve to find someone else. It was either a Friday or Saturday when he phoned and when I said, "That sounds like an interesting job, when do I start?" he replied next Monday. Short notice but pipeline work can be a bit like that.

There are so many species that I have removed, but some that come to mind were the numbers of *Pseudonaja* that we relocated up in the Channel Country. There were five species and many different colour patterns. Plus the occasional Inland Taipan.

On another job in Queensland the endangered Ornamental Snake (*Denisonia maculata*) was the second most common snake we removed from the trench; very localised, but very common where it occurs. Centralian Blue-tongues by the bucketful on one job where we had a Spinifex fire that burnt along the trench line and resulted in huge numbers of animals in the trench. Although we had removed this species from the trench before it was never in big numbers. It was a surprise to find out just how common they are.

Neville: Who was behind the idea to have guys like you and Steve working on the gas lines?

Gerry: As far as I can remember it was accidental.

Above left: *another rare photo of Gerry involved in pipeline work.*
Right: *a typical pipeline trench.*

Left: reptiles aren't the only animals that require rescuing from the pipeline trenches!

The pipeline construction company contacted the Queensland Museum and Steve took the call. They wanted someone to remove dangerous animals from the trench. Steve had a think about it, got back to them and took on the job. He soon convinced them that minimising the impact of the pipeline on native fauna, not just dangerous animals, was the way to go. Most of the pipeline work we have done has been with Nacap Australia and they have been very supportive of fauna conservation. They have also got good mileage by promoting the positive aspects in various media outlets along the way.

Neville: What are the conditions of your work on the pipelines? How long do you spend on site and at what intervals?

Gerry: On the first job we did 28 days on and seven days off. But it quickly became obvious to everyone that there was open trench during the seven-day break and that someone had to be there to check the trench during that time. Because we were going to be out of step with everyone else we were told to put together our own roster. We did this on the basis of 14 days on and 14 days off, with Steve there for one 14-day period and me for the next. This meant one of us was always on site.

Neville: It's good to see conservation in action like this and it must be very exciting never knowing what each new day will bring in the way of species. I think a lot of people would be envious of the chance to work on one of the world's largest pit traps - I know I am! Thanks very much for your time Gerry and I hope that you and Steve continue to contribute to our knowledge of Australian herpetefauna.

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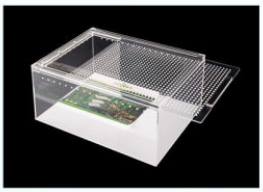
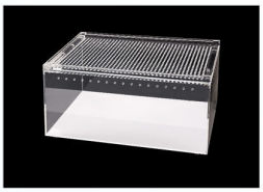
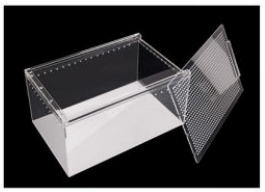
ACR03B - 15 X 20 X 15cm (2mm) : Black







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*Conservationist and wildlife advocate **Ben Dessen** is Reptiles Department Manager at Kellyville Pets and is passionate about educating newcomers to the reptile hobby. This time it's back to basics, with one of our most loved and popular native reptiles.*

Blue-tongue Basics.

With a resurgence in popularity over recent years - largely due to the myriad of colour variations now available - the humble blue-tongue has certainly been put back on the herpetological map! What was once considered a common, entry-level animal is now a highly sought-after and prized addition to many experienced reptile keepers collections around Australia. However, for newcomers to the hobby, the blue-tongue still represents a great starting point due to its typically docile nature and general hardiness in captivity (if provided with the right environmental conditions). So, let's get back to the basics and take a look at the husbandry and care requirements for blue-tongued lizards.

General information.

The genus *Tiliqua* is comprised of some of the largest members of the skink family, with six species native to Australia:

Eastern Blue-tongue; *Tiliqua scincoides.*
Centralian Blue-tongue; *Tiliqua multifasciata.*
Blotched Blue-tongue; *Tiliqua nigrolutea.*
Western Blue-tongue; *Tiliqua occipitalis.*
Pygmy Blue-tongue; *Tiliqua adelaidensis.*
Shingleback; *Tiliqua rugosa.*

In addition, there is also at least one species found in Indonesia:

Indonesian Blue-tongue; *Tiliqua gigas*.

In the wild, blue-tongues are found right across the continent and inhabit a range of different environ-

***Left:** the Eastern or Common Blue-tongue is found throughout much of eastern and northern Australia. Image by Michael Cermak.*
***Above right:** it's not difficult to see how these skinks got their name! Image by lady-photo.*

ments, from central arid regions through to coastal eucalypt forests and alpine woodlands. As such, their captive requirements vary based on their natural habitats and climate. For the purpose of this article, the information presented will be primarily directed towards the husbandry of the Common or Eastern Blue-tongue, as this species is generally the most suitable for new reptile keepers, and is readily available. Much of the information is relevant to multiple species, however temperature and humidity requirements can differ significantly.

Blue-tongues are generally long-lived in captivity and can easily reach 10-15 years of age, with some specimens having a lifespan of more than 20 years. Gender can be difficult to identify to the untrained eye, and it is nearly impossible to determine the sex of juveniles. An experienced keeper may be able to distinguish gender visually by looking for differences in head shape and body proportions as well as other anatomical features. Adult blue-tongues can also be probed or (in the case of males) have their hemipenes everted, however these techniques should only be attempted by an experienced keeper or veterinarian.

Housing.

Blue-tongues are slow-moving, terrestrial skinks, and in their natural environment spend the majority of their time living amongst fallen timber, leaf litter, vegetation and in rocky crevices. Therefore, in captivity enclosures that are longer than they are tall are important to allow these lizards plenty of floor space to engage in natural foraging and basking behaviours. Like many other reptiles, blue-tongues are considered solitary creatures and are generally best housed on their own. Having more than one blue-tongue in an enclosure may lead to issues associated with dominance and aggression.

Timber or glass reptile enclosures are the ideal housing option for blue-tongues and should be no smaller than 90cm x 45cm x 45cm for one adult lizard. Enclosures measuring 120cm x 60cm x 60cm will provide the animal with a larger surface area in which to explore and remain active. It is important that there is sufficient ventilation, as well as a secure, lockable door. Many keepers also successfully house blue-tongues in outdoor enclosures and lizard pits.

Essential furnishings include a number of hides placed at both the hot (basking) and cool ends of the enclosure, a small water bowl and a suitable substrate. A number of substrates can be used for blue-tongues including coconut fiber, aspen, newspaper and synthetic grass mats. Coconut fiber makes a practical and aesthetically-pleasing choice, as it is cheap and highly absorbent. If applied to a reasonable depth in the enclosure, it will also allow the lizard to dig and bury itself. Artificial plants and timber logs can be incorporated into the enclosure design to provide a more natural and stimulating environment.

It is important to maintain high standards of cleanliness and hygiene within the blue tongue's enclosure. Daily 'spot checks' should be carried out to remove any faeces, shed skin or uneaten food. A full substrate change should be undertaken every six to eight weeks (maybe more frequently depending on the type of substrate used) and the enclosure thoroughly cleaned with a reptile-safe disinfectant.

Heating and lighting.

The provision of suitable temperature gradients within the enclosure is essential for a blue-tongue's health and wellbeing. Being a coastal species, Eastern Blue-tongues require slightly cooler temperatures than their inland cousins, with a basking spot of between 30-33˚C being appropriate. The lizards should have access to a slightly elevated piece of flat timber or rock to allow them to bask closer to the heat source - keep in mind they are not great climbers. Ambient temperatures should be maintained with a gradient of 24-28˚C and should not drop below 18-21˚C at night.

Temperatures should be checked daily and regulated with the use of a high-quality thermostat. Recommended heat sources include incandescent, halogen and ceramic (night time only) globes coupled with a good-quality heat mat as a secondary source of under-floor heating.

Ultraviolet light (UV) plays an important role in a blue-tongue's growth and development. A 5.0-10.0 UVB tube or compact globe can be used as an adequate source of artificial UV lighting in the lizard's enclosure. Blue-tongues also benefit from access to unfiltered, natural light at least once or twice a week. They require a day and night cycle with heat and UV lights running for approximately 12 hours each day, set on a timer.

Nutrition.

Blue-tongued lizards are omnivorous and feed on a range of plant matter as well as live insects in the wild. In captivity, they are by no means fussy eaters and will consume almost anything offered. A good

diet should consist of a variety of chopped fresh fruits and vegetables as well as live and processed foods. Fruits and vegetables should make up around 70-80% of their diet and can include apple, pear, melons, pitted stone fruits, berries, banana, squash, carrot, endive and kale. Blue-tongues have a sweet tooth and love soft fruits, however these should be fed in moderation as they can lead to loose faeces.

Live foods that can be offered to blue-tongues include snails, crickets, woodies, mealworms (in moderation), Black Soldier Fly larvae (BSFL) and silkworms. All live foods should be dusted with a calcium and multivitamin powder before being offered to the lizards (with the exception of BSFL and silkworms). Blue-tongues are relatively slow-moving and may have trouble catching faster insects such as crickets and woodies. Placing feeder insects inside a shallow bowl may prevent them from hiding in the enclosure and assist the lizard in catching them.

Blue-tongues can also be fed small amounts of tinned dog food (beef or chicken) with added calcium powder, as well as diced boiled egg. Commercially available lizard pellets and pre-mixed diets can also be offered to provide variety and extra nutrition. The secret to a healthy lizard is a complete and varied diet. Juvenile blue-tongues should be fed daily and adults can be offered food every two to three days. Fresh water should be available to the lizard at all times and changed daily.

Common health issues.

In many cases, health issues in captive reptiles are a direct result of poor husbandry or an improper set-up. If a reptile's essential heating, lighting, enclosure and dietary requirements are met, it should thrive in captivity. If a reptile displays any abnormal behavior, the best course of action is to get it assessed by a reptile veterinarian ASAP. Some of the most commonly encountered health issues in blue-tongued lizards include:

Metabolic Bone Disease. This results from calcium or vitamin D3 deficiency as a result of a poor diet and/or incorrect or insufficient UV lighting. Symptoms may include spinal/tail kinks, weakness, lethargy and muscle spasms.

Dysecdysis. Low humidity can cause a blue-tongue to have an abnormal or poor shed. Lizards do not shed their skin in one long piece like snakes do, but in patches. After a lizard has shed its skin, it is important to check its extremities (tail tip; toes; grooves around the limbs) to ensure all old skin has been removed. Retained skin may cause constriction and can result in infection and ultimately the loss of toes and tail tips. Soaking the lizard in a shallow tub of warm water can assist in the removal of any pieces of retained skin.

Respiratory Infection. Low temperatures and high humidity for extended periods can lead to respiratory infections in lizards. Symptoms include sneezing, discharge around the nostrils and mouth, coughing, lethargy and loss of appetite.

Parasites. Blue-tongues are susceptible to a number of both internal and external parasites. Mites can cause severe irritation and can be contracted from contaminated furnishings placed inside the enclosure or from new animals introduced into a collection without proper quarantine protocols being followed. A mite infestation can induce constant scratching, or the lizard may continuously soak itself in the water bowl. Most reptiles also naturally carry parasites within their gut. During times of stress or if an animal is not housed correctly, these parasites can proliferate and may cause health complications.

Left: *a 120cm timber enclosure ideal for blue-tongues that features glass, sliding, lockable doors and flow-through ventilation, along with a built-in thermostat.*
Above right: *blue-tongues are popular with many young reptile enthusiasts, like Julia, because of their docile nature and hardiness in captivity.*

Morphs.
Although blue-tongue morphs have been present in the hobby for many years, it is only relatively recently that their popularity has spiked due to the development of some amazing new lines and mutations. Blue-tongue morphs make truly stunning pets for those wanting something that little bit different. However, whilst their husbandry and care is no different to that of a regular blue-tongue, their price tag is substantially greater, with some specimens selling for thousands of dollars.

Blue-tongued lizards make fascinating pets for beginners and experienced reptile keepers alike. With their relatively straightforward husbandry requirements, and the range of colour variations available, there's no reason why every Australian keeper shouldn't have one of these truly iconic native reptiles as part of their collection.

Write to Ben care of iHerp Australia if you have a topic you would like to see him cover.
Or you can contact him direct via Instagram: @bendessen, *or his website:* www.bendessen.com.au

Who's Who in the Poo?

Commonly seen intestinal parasites of reptiles.

***Dr Thomas Vowell**, of Glenorie Vet Clinic, examines some common internal parasites.*

Internal parasites are a common finding in many clinical examinations of captive and free-living reptiles, and for this reason it is important to get a regular faecal examination done at least once a year to keep an eye on any parasitic burdens your pets may have. This can be done as part of an annual health check with your local reptile-savvy vet. Not all internal parasites will cause your pet a problem and require treatment, and this is dependent on factors such as: the reptile's diet; the health status of the reptile; and its age. Regular faecal sampling can help provide a more rounded picture of your reptile's gut parasite levels and help when deciding if a parasitic load is likely to cause a problem. Some parasites may even be beneficial in assisting digestion. This article aims to look at some of the most common internal parasites and offer some management suggestions to help prevent problems.

Coccidia.
Coccidia are a group of single-celled, intracellular parasites that most commonly cause disease in juvenile reptiles such as bearded dragons (*Pogona* spp.). Some species of coccidia affect the gastrointestinal tract, and others target the bile ducts in the liver. Coccidia shed oocysts in the reptile's faeces, which then mature in faeces left in the enclosure and are taken back up by your pet orally. Finding coccidia eggs in a faecal examination doesn't necessarily mean that your pet is adversely affected by the presence of the parasites. The changes you should look out for that may indicate your pet has a parasite infection are non-specific and include (but are not limited to): decreased appetite; weight-loss; change of faecal formation; and lethargy. If you notice any of the above signs it is important to book a visit with your local reptile vet and take a faecal sample for testing. Treatment of coccidia is most often aimed at reducing the burden of parasites to a level such that your pet's own immune system can take care of the rest. Strict cleaning and hygiene is recommended as part of any treatment program.

Hookworms and roundworms.
Hookworms (family Strongylidae) and roundworms (family Ascarididae) are intestinal worms commonly seen in both captive and free-ranging reptiles. In large numbers they can cause blood loss and weight loss through intestinal inflammation and ulceration and in very severe cases they can cause death. Like coccidia, these worms also have a direct lifecycle, being shed in the faeces and then taken in orally from the environment by your pet. These worms can also be identified on a routine faecal check.

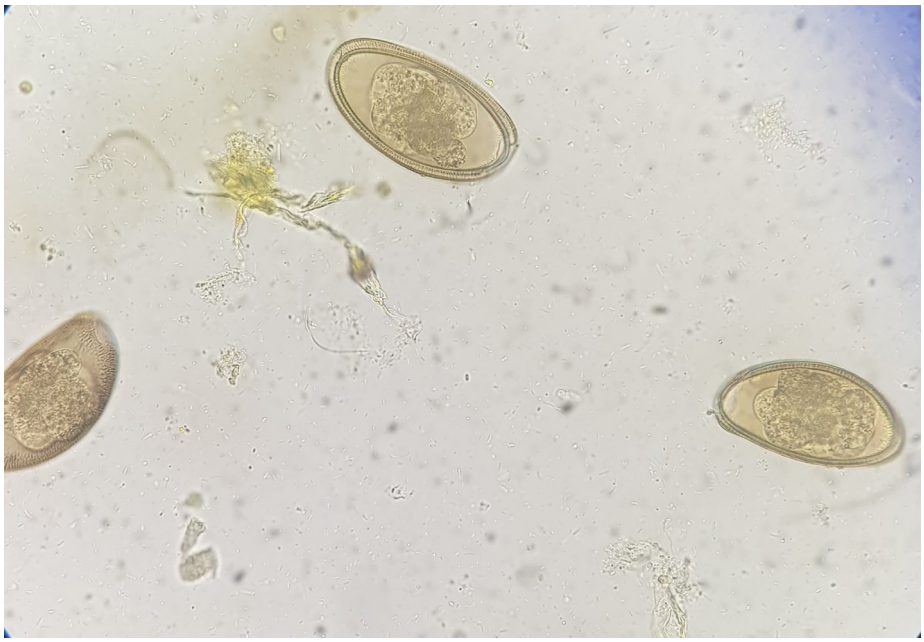
Pinworms.
Pinworms (*Oxyuris* spp.) are another common parasite but do not always cause problems for your pet. For example, they are often found in herbivorous reptiles such as adult bearded dragons, and it has been hypothesised that they have a beneficial effect in helping break down vegetable material, thereby making it easier for the lizard to digest. It is only in large numbers that these parasites pose a problem; if the burden is not heavy, removing them may have a negative effect on the reptile's digestion.

General principles of intestinal parasite management and prevention.
Intestinal parasites do not tend to reach levels that will cause problems in free-

***Left:** Coccidia eggs at 400x magnification from a faecal float. Image courtesy of Dr Roger Klingenberg (https://www.merckvetmanual.com/digestive-system/coccidiosis/overview-of-coccidiosis).*
***Above right:** Pinworm eggs under 400x magnification from a fecal float of a two-month-old bearded dragon. Image courtesy of Dr Tiffany Alexandra, Mackay Veterinary Hospital, Queensland.*

ranging, wild reptiles as these animals can move away from their faecal material to break the faecal-oral cycle of most of these parasites. Captive reptiles are constrained by their enclosures, which prevent them from getting too far away from their faeces. Over time this can cause a superinfection of parasites leading to the heavy burdens which cause disease. The key to preventing heavy burdens in captive reptiles is to break the faecal-oral cycle. Consideration s include:

- altering the feeding routine;
- suitable choice of substrate, and;
- enclosure disinfection and cleaning.



Changing your feeding regime is a good way to help prevent the spread of parasite eggs from faeces to your pet. Feeding lizards invertebrates, such as crickets, as part of a balanced diet is essential, however placing the invertebrates in the enclosure and allowing them to roam freely until the lizard eats them can exacerbate a parasite problem. The invertebrates will both ingest the reptile faecal material containing the parasite eggs and collect it on their external surfaces; when the invertebrates are consumed by a lizard, this will perpetuate the parasite's life cycle, resulting in a heavier burden. Feeding insects via tweezers or feeding lizards in a separate container - allowing them to eat as many insects as they can in five minutes before replacing them in their enclosure - breaks this cycle.

There is a wide variety of substrates available, ranging from those that are easy to clean (e.g. newspaper) to those that look good but are harder to keep clean (e.g. bark chips and reptile sand). It is important to find an appropriate balance between the aesthetics and enrichment benefits, and hygiene and ease of cleaning. It is also important to assess the depth of the substrate - the deeper it is the harder it will be to keep clean. Regardless of the option you choose, the enclosure should be cleaned regularly with a suitable disinfectant, and faecal material should be removed as soon as possible and not allowing it to sit in the enclosure. A regular complete disinfection of the enclosure with a commercial grade disinfectant (e.g. F10 or Trigene) will help reduce the parasitic load in the enclosure and prevent further reinfestation from faecal contamination.

Prevention is better than a cure; intestinal parasites are common in young captive reptiles, and the maintenance of appropriate management protocols coupled with regular veterinary examination of faecal samples will help prevent the necessity for more complicated treatments.

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What's NEW.

An Apple a Day Won't Keep the Dentist Away!

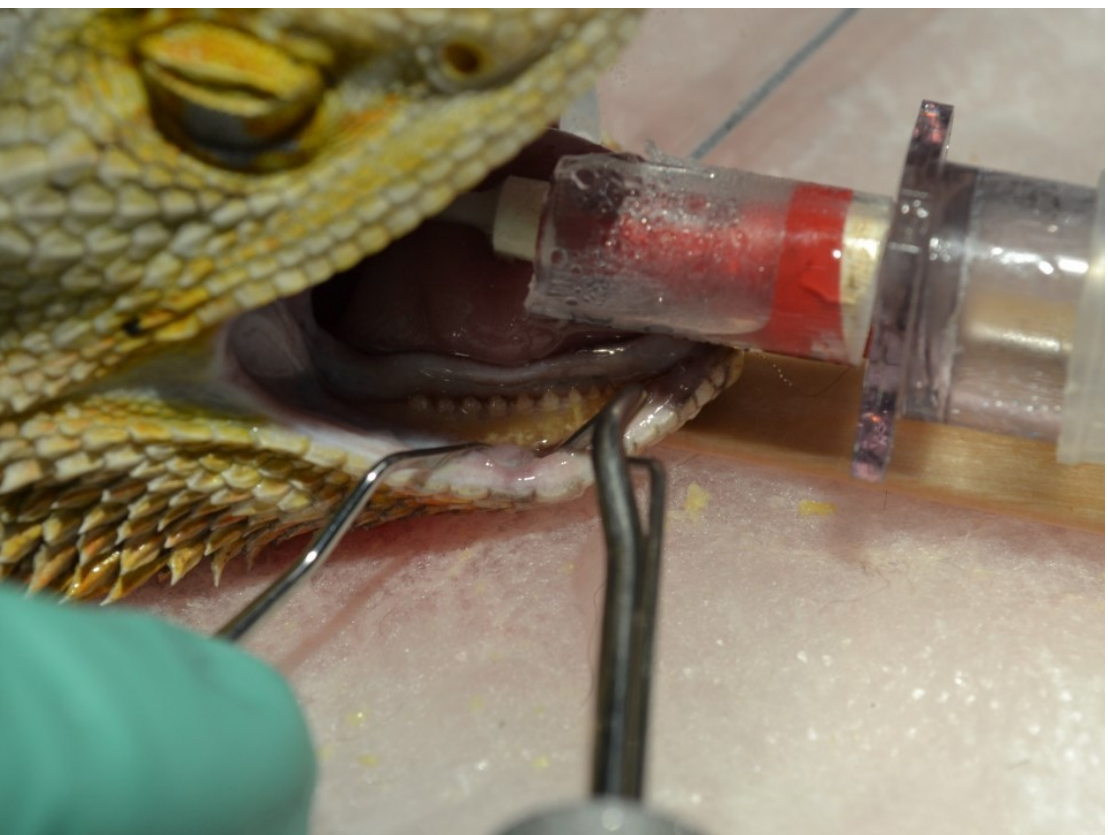
The Reptile Doctor, ***Dr Shane Simpson****, details an insidious affliction suffered by many captive dragons.*

Let's face it. Going to the dentist is not on most people's list of favourite things to do. It's hard enough getting ourselves to the dentist let alone getting our pet's teeth checked by a vet. But dental disease is not just confined to our dog and cat companions. It is actually a common problem that can affect reptiles….and specifically dragons.

History.
Dental disease, and specifically a type called periodontal disease, was first described in dragons at the 1994 Association of Reptilian and Amphibian Veterinarians conference. In that presentation, the authors discussed the clinical findings, treatment and management of 39 cases in an assortment of lizard species at Melbourne Zoo over a five-year period. Importantly they examined the mouths of some preserved specimens at the Museum of Victoria and found none of these animals showed any evidence of periodontal disease. It was therefore inferred that this was a syndrome of captivity. The authors also made some suggestions regarding the potential dietary causes of periodontal disease in dragons and the dietary changes that should be considered in order to prevent the development of this condition. More than 20 years later, there appears to have been little change in the captive diets fed to dragons and as such periodontal disease continues to be a common problem.

Anatomy and pathogenesis.
The dental anatomy of dragons or agamids, along with those of chameleons and tuatara, is unique amongst the lizards. These three groups have a type of tooth structure called acrodont dentition. Their simple triangular-shaped teeth are fused to the jaw bones and are not continually replaced throughout life. As such, damaged teeth are retained rather than shed. In addition the bone-gum junction in these species is located several millimetres away from where the tooth joins the jaw bone. The small section of bone between where the tooth is fused in to the jaw and where the gum stops is covered by a thin, dull, enamel-like layer that repels bacterial invasion. Like periodontal disease in mammals it appears the primary cause is bacteria, and so when this layer is damaged bone is exposed upon which bacteria are able to colonise and establish themselves. Furthermore, if soft diets are fed to the lizards, bacterial numbers increase due to the fact there is a lack of abrasion of the tooth and gingival surfaces. The bacteria release toxins and incite inflammation of the gum that if left unchecked can result in bone infection and worse.

Many different species of bacteria have been isolated from the infected mouths of reptiles. Specific samples taken from those animals described in 1994 found that both aerobic and anaerobic bacteria were present in 15 out of 17 affected animals. Swabs taken from a small number of normal lizards at the same time only demonstrated aerobic bacterial growth. This parallels the development of mammalian periodontal disease, in



Left: *bearded dragon undergoing dental cleaning.* ***Right:*** *series of images depicting grading of periodontal disease. All images courtesy Dr Shane Simpson.*

which the oral flora switches from being predominantly aerobic to including anaerobic bacteria.

Clinical signs.
Dragons with periodontal disease may present with a range of signs. These include:

i. Asymptomatic. Dragons, even those with advanced periodontal disease, may show no signs of an issue and the condition is only detected upon examination.
ii. Loss of appetite.
iii. Weight loss.
iv. Pain on chewing.
v. Bleeding from the mouth.
vi. Loss of teeth and jaw bone.
vii. Swelling of the jaw bone.

Grading.
Veterinarians like to assign grading systems to conditions as it allows a more accurate description of the problem. The severity of periodontal disease in dragons can then be graded using the following system:

Grade 0 = Clinically normal.
Grade 1 = Staining only.
Grade 2 = Mild tartar development; mild gum redness.
Grade 3 = Moderate tartar development; moderate gum redness and recession.
Grade 4 = Severe tartar development; severe gum recession; +/- bone infection; +/- bone fracture.
Grade 5 = Loss of jaw bone.

Right: *rotten jaw bone removed from dragon exhibiting Grade 5 periodontal disease.*

Treatment.
There are several facets to the successful treatment of periodontal disease in dragons. The first component is the removal of the calculus and staining. To achieve this the animal must be anaesthetised. The mouth is held open using a cut-down syringe cap or commercially available mouth props. An ultrasonic, hand dental scaler is then used to remove the calculus and tartar. In severe cases, a high-speed dental drill fitted with a small round burr may be required to remove the calculus. Care should be taken not to damage the teeth during this process. Areas of bone infection can be identified by the finding of soft sections of bone in the jaws and also on X-rays. These affected areas should be cleaned free of infected bone.

The entire area can be flushed with saline or antiseptic solutions containing chlorhexadine or betadine. In cases of bone infection, the use of appropriate antibiotics is warranted and required. In some cases they may need to be given for 8-12 weeks. Topical treatments may be used in addition to antibiotics to encourage local effects.

Prevention
There are several methods that can be employed to prevent the development and/or recurrence of periodontal disease in dragons. These include:

i. **Dietary change.** Captive dragons are routinely maintained on diets composed primarily of soft-bodied insects, fruits and vegetables. In addition it is common for captive diets to be based primarily upon vegetation. The problem with this type of diet is twofold. Firstly, soft foods require little chewing by the lizard. This results in little abrasion of the teeth, allowing for bacteria to accumulate and periodontal disease to develop. Secondly, the gut of dragons is not designed to digest large amounts of fibre. They have a relatively short gastrointestinal tract with little area for fermentation of fibre. While in the wild they eat a variety of insects, fruits and flowers, there is much seasonal variation and the predominant component of the diet consists of harder-bodied insects and tough sclerophyll plants and flowers. The supplementation or replacement of part of the diet with some native Australian vegetation such as *Eremophila* spp., *Hemiandra pungens*, croweas, correas and grevilleas should be considered. In addition to the types of food being fed one should consider the size of food items being presented. It is commonplace for dragon owners to grate their pet's food into small pieces. This in turn results in less chewing being required. As such it is recommended that food items be chopped into pieces rather than grated.

ii. **Regular dental hygiene.** A cotton bud dipped in chlorhexadine solution can be used as an effective toothbrush for dragons. When used to brush the teeth 2-3 times a week, this may aid in the reduction of bacteria on the teeth and slow the progression and recurrence of peridontal disease.

iii. **Use of dental prophylaxis products.** Products such as Hexarinse, Maxiguard Oral Gel and Curasept Gel may be used to provide prolonged antibacterial effects in order to prevent periodontal disease.

Owners of dragons should be regularly checking the mouths, and specifically the teeth, of their pets. When caught early, periodontal disease can be treated and prevented from getting worse.

Best Blogs.

Head over to the **iHerp Australia** website for your weekly serve of news and comment. Here is one of our recent blogs:

Stir-fried Snake.

The town of Buntulu, near the Kelawit River in Borneo, has a favourite recipe in which meat is grilled or fried with vegetables and then served with rice. Sounds pretty standard fare – except that the meat in question is actually snake!

So the townsfolk were understandably delighted when hunters recently brought in a massive 20-foot (six-metre) Reticulated Python, along with her much smaller mate, upon which they would feast for days. The hunting party had heard noises emanating from a hollow log. Tinsung Ujang recalled, "I looked down into the hole in the wood and was surprised to see the female mating with a smaller male snake. We had to split the timber to reach them. They were locked together; I have never seen snakes mating before."

The snakes were extricated with the aid of a chainsaw, before being shot and taken back to town on the back of a pick-up truck. Their arrival was greeted by cheers from hungry locals!

Snake meat has long been considered a delicacy in many cultures. Snake soup, in which the main ingredient is the shredded meat of at least two species of snakes, has been relished by the Chinese for more than 2,000 years, not least because it is purported to have medicinal qualities and represents a symbol of wealth and machismo. The popularity of this dish boomed in Hong Kong in the 1980s, with more than 100 restaurants specialising in snake soup.

Similiarly,the village of La Mat, now a suburb of Hanoi, in Vietnam, is famous for a number of eateries that offer all manner of exotic wildlife. Snakes are prepared in a well-rehearsed pantomime which involves disembowelling the live reptile, and then draining its blood and bile, together with the still-beating heart, into shot glasses, which are then knocked back by patrons in a sort of 'rite of passage'. The rest of the meat is then served up in an extravagant array of different courses.

Snakes are also widely consumed in West Africa, and snake meat is used as part of traditional medicine in South America.

And let's not forget the US, where rattlesnake round-ups are still held in at least ten states, and a portion of the catch ends up on the table, often barbecued or southern fried. Although targetted by conservationists and animal welfare groups, these events can be important to local economies, with the largest round-up, in Sweetwater, Texas, attracting around 30,000 visitors every year.

For the original story go to:
www.dailymail.co.uk/news/article-5380727/Hungry-villagers-Borneo-cook-20ft-python-stir-fry.html

Above: *delicious! Snake soup has been relished in China for more than 2,000 years. Image by DavidNNP.*
Left: *grilled snakes on sale in a food market in China. Image by WeStudio.*

The King Needs YOU!

Unique opportunity to assist in King Cobra field research.

The Agumbe Rainforest Research Station is currently offering a unique opportunity for herping enthusiasts from around the world to participate in Phase II of their King Cobra Ecology and Conservation project (KCEC). Founded by leading Indian herpetologist Romulus Whitaker in 2005, the ARRS is situated inside the Agumbe Reserved Forest in southern India's Western Ghats, and is an eco-friendly facility that conducts a wide variety of field-based research projects as well as education and outreach in the local community.

The ARRS was responsible for the world's first radio-telemetry project involving King Cobras (*Ophoiophagus hannah*), which was also the first of its kind in India. Insight gained from this study is already being used in management of King Cobras in the region.

Recently, the ARRS embarked on a second phase of King Cobra radio-telemetry, and is recruiting volunteers to assist with tracking and observation.

This project consists of implanting King Cobras with transmitters and tracking them, using receivers, through their natural habitat to learn about the habits, biology and conservation of these remarkable creatures.

The primary questions to be answered involve foraging patterns, home range, habitat utilization, diet, interaction with other King Cobras and, hopefully, recording nest building, nest maintenance and attendance by the females.

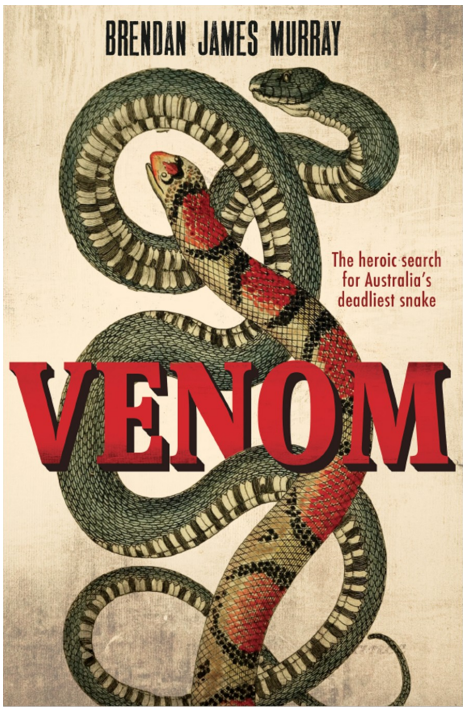
Food and accommodation will be provided with basic amenities. The volunteers will be living in the midst of rainforests at the ARRS field station near the village of Agumbe. Primary selection criteria are physical fitness (for field work), a willingness to work during challenging weather conditions, a passion for conservation, and a minimum commitment period of one month.

This important and exciting phase of the project commenced March 2018 and should run for a couple of years, based on the battery life of the transmitters. More volunteers are required and slots are now open until September 2018.

Rom Whitaker and his dedicated team are world leaders in the study of King Cobra ecology. This would be an amazing, once in a lifetime experience for anyone with an interest in herpetology, and iHerp Australia would love to hear from any of our readers who become involved. If you are interested, please contact: operations@agumberainforest.org.

Above left: *Dr Matt Goode briefing first-toime King Cobra radio trackers. Image by Rom Whitaker.* ***Left:*** *courting pair of King Cobras, western Ghats, south India. Image courtesy ARRS.*

A Good Book.



Echo a division of Bonnier Publishing Australia; Paperback; 385pp; AU $32.99; ISBN 9781760405694 .

Reviewed by **Michael Cermak.**

In essence, this book describes events and stories between the time of European settlement and the first production of taipan antivenom.

The author, Brendan James Murray, is a high school teacher with a fascination for reptiles and considerable writing skills. He spent between six and eight months researching the topic and conducting interviews - travelling as far afield as north Queensland. For someone who is not a herpetologist, it was an ambitious and lengthy project that required a huge amount of investigation; following leads to contact those few old herpers still alive and relatives of those who aren't.

The hero of the book is George Rosendale, an Aboriginal man now living at Hope Vale in north Queensland, the only person who survived a taipan bite without the aid of antivenom. The ordeal is vividly described by Rosendale himself, and the following chapters shed light not only on his life and experiences but touch deeply on the sufferings that Aboriginal people endured (many didn't survive) in the early days.

It's astonishing how many people died as a result of taipan bite - and in most cases how fast. The author explains: 'In *Venom* I refer to about fifteen fatal cases that probably involved taipans, and there were plenty of others I could have included. It had a significant impact on the public consciousness of the time, but actually wasn't a major issue when compared to other dangers like farming accidents. Snakes, though, seem to trigger a primal fear and awe in many people.' Some of the cases described send shivers up the spine, particularly one instance in which a chisel was driven into the bite site to induce bleeding. The desperation of doctors watching their patients die must have been horrific.

Many well-known names are mentioned in the book, however, one person's story stands out – that of the life and death of Kevin Budden and his quest to catch the first wild taipan. Although the subject matter gives the book a rather sombre feel, there are funny parts, along with the happy story of the survival of the young Bruce Stringer, the first recipient of the 'experimental' taipan-specific antivenom in 1955.

It's hard to find any criticism of this book, although I would have liked to have seen an explanation of the current pressure immobilisation first-aid treatment. The cover of the book received mixed responses from the herp community, but the fact is that an author has little say as to the cover layout, which in this case succeeded in appealing to a broad audience.

Venom documents an important chapter in Australian herpetological history, which must never be forgotten or overlooked. It is eloquently written, factual and engaging - a must read for every herper, whether you like taipans or not.

Train the Brain or go Insane!

Reptile Cognition, Welfare and the Importance of Behavioural Enrichment for Captive Herps.

Mitchell Hodgson *is in the process of completing a PhD on the thermal physiology and behaviour of Jacky Dragons, and is a familiar face in the reptile department at Kellyville Pets. In this issue he investigates whether behavioural enrichment can deliver any real benefits for captive herps – and their keepers.*

We live in an era where every second heated debate about captive herps relates to whether tubs, tanks or outside is best for our pets. After starting a discussion on a Facebook group about barren tub set-ups, I was forced to wonder about how important behavioural enrichment is for captive herps? Is there really any impact on their wellbeing? After exploring some veterinary and zoological literature I hope to provide a bit more of an informed basis for keepers to make decisions about the use of enrichment in their captive regime. Please keep in mind that this isn't an attack on a keeping style (everyone takes these discussions so personally!), but rather a toolbox of tips to help improve your captive environment.

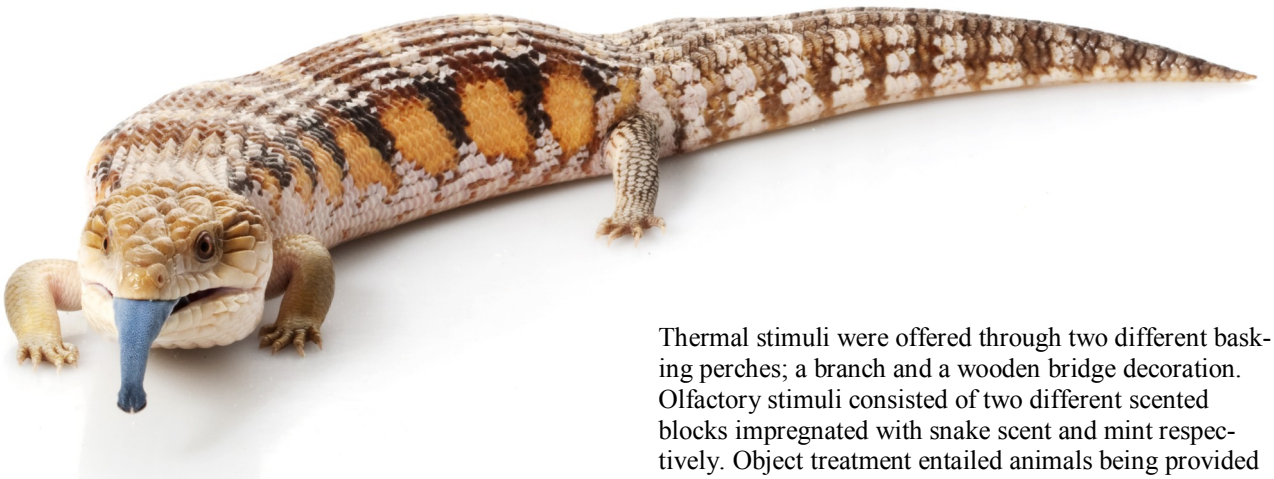
I think the best way to start looking at this topic is by debunking the misconception that reptiles are 'dumb'. I'm not trying anthropomorphise your pet herp and argue it is capable of complex emotions such as love, loss and affection. But squamate reptiles have evolved a suite of cognitive (evidence-based learning and decision making) abilities to help them survive in the wild, such as complex spatial learning and social learning. Central Bearded Dragons (*Pogona vitticeps*) have even been able to imitate each other opening a sliding door for a food reward! Unfortunately, much of the early research on reptile cognition and captive behaviour utilised methods appropriate for studying birds and mammals – the scientists were asking questions the wrong way. Reptiles quickly fell into the shadow of the other two taxa, which is disheartening as some contemporary studies suggest they have an equal amount, or in some circumstances greater diversity of behaviours. In the past five or so years the global interest in pet reptiles has boomed, and so has the quantity and quality of work investigating their wild and captive behaviour.

Think of enrichment as solving a riddle; it's a mental workout, like physical exercise to stay healthy. Without mental stimulation to keep the reptile mind ticking over, our pets are susceptible to poor wellbeing, which may be to the detriment of their behaviour, overall health and, god forbid, breeding success! Behavioural enrichment is intrinsically linked to the concept of welfare, which is dependent on animal-environment interactions. In modern welfare science there are three key concepts:

1. An animal's perception of its environment is a determinant of welfare.
2. Good welfare requires stimulation through overcoming challenges.
3. Welfare is improved by changes to the environment or changes to the way that animals perceive the environment.

Furthermore, there is evidence to show that certain factors of captive animal environments are strongly correlated with welfare, including similarity to the natural world, the ability of the animals to make choices, meeting species-specific needs and overall environmental complexity. How many keepers out there think they have achieved those criteria effectively? I know I'm probably barely scraping through.

Right: *Central Bearded Dragons have learned to open a door to receive a food reward. Image by ifong.*



What makes the whole process of understanding reptile welfare and wellbeing even more messy is there are no perfect methods to measure these concepts. The most common way welfare is measured is through observation of abnormal repetitive behaviours (ARB; also referred to as stereotypic behaviours). This focuses on how often the animal repeats an extended behaviour that has no achievable goal or function. Similarly, welfare has also been measured in terms of the number of attempts to interact with transparent boundaries (ITB) such as nclosure walls. Classic reptile examples of ITB include blue-tongues (*Tiliqua* spp.) repeatedly attempting to climb the edge of an enclosure; water dragons (*Intellagama lesueurii*) running the wall of an enclosure and rubbing their noses until they get oozing abrasions; or snakes kept in tubs continually probing the walls of their enclosures. These two metrics serve as an interesting counterpoint to what I believe are the two most commonly used measures of 'success' and 'wellbeing' in the hobby, being reproductive output (large clutch size and large egg mass per clutch) and weight of animals.

In the following paragraphs I'm going to discuss some taxa-specific studies for lizards, snakes and turtles. It is important to realise is that scientists are constrained by time, effort and money. As a result, a lot of broader concepts are investigated through a single species as a model organism. Even though each of the following examples is focused on a single species (and is additionally constrained by the limited number of animals tested) it doesn't necessarily follow that the results are restricted to that species. Conversely, it doesn't mean the results are true of all reptiles of that group.

Leopard Geckos (*Eublepharis macularius*) and five types of enrichment.
Bashaw, M. J., Gibson, M. D., Schowe, D. M. & Kucher, A. S. (2016). Does enrichment improve reptile welfare? Leopard geckos (Eublepharis macularius) respond to five types of environmental enrichment. *Applied Animal Behaviour Science*, 184, 150-160.

Bashaw et al. used a group of captive-bred Leopard Geckos to investigate the welfare benefits of enriching captive environments through five different types of stimuli: feeding, thermal, olfactory, object and visual. Feeding stimuli involved offering the geckos crickets through two different puzzle feeders, one being commercially available and the other home-made from PVC pipe. Thermal stimuli were offered through two different basking perches; a branch and a wooden bridge decoration. Olfactory stimuli consisted of two different scented blocks impregnated with snake scent and mint respectively. Object treatment entailed animals being provided with two different dog toys to interact with; a ball and a rolling cylinder. Lastly, the visual component involved supplying animals with a mirror so that they had access to their reflection.

Unsurprisingly, the animals were found to interact with all the stimuli at levels that statistically speaking were not random (meaning the lizards were choosing to interact with the stimuli). The feeding, thermal, olfactory and object treatments were all found to change the specific behaviours of the geckos and greatly increase the diversity of behaviours they displayed. This suggests a corresponding improvement in the animals' welfare. Furthermore, animals that were stimulated also spent a greater amount of time performing exploratory behaviours throughout the cage.

Changing the behaviours of rat snakes through simple environmental enrichment.
Almli, L. M. & Burghardt, G. M. (2006). Environmental enrichment alters the behavioral profile of ratsnakes (Elaphe). *Journal of Applied Animal Welfare Science*, 9 (2), 85-109.

This study investigated how snake behaviour changes in an enriched environment as compared to 'standard' housing. Animals housed in standard conditions were maintained in small enclosures with a single hide, a brick and paper substrate. Enriched animals were housed in the same size enclosure, but were given aspen bedding, a moist hide and a climbing log with a hide of sorts on top. There were also two different feeding regimes; standard animals were fed dead prey while enriched were fed live prey items. As a brief sidenote, live feeding vertebrate prey is an entirely different ethical ballpark and careful consideration should be used in determining if it is required for your situation, which in most circumstances it isn't.

What the researchers found was something I think a lot of snake breeders will appreciate. Staggeringly, snakes from enriched environments grew much quicker than those in standard conditions. On top of this, snakes from enriched environments were shown to exhibit less stress in unfamiliar situations or environments and had superior problem-solving abilities. These findings have wide-ranging implications: breeders can reduce growing times by enriching a snake's environment, whilst those with pet snakes can enrich their animals' enclosures to limit stress -related behaviours such as non-feeding or cage-defensiveness (as it is commonly called). The researchers also concluded that feeding live prey didn't increase the prey handling capacity of the snakes (in terms of missed strikes, handling time, swallowing time, etc.).

Turtle 'play' reduces self-mutilation.
Burghardt, G. M., Ward, B. & Rosscoe, R., 1996. Problem of reptile play: Environmental enrichment and play behavior in a captive Nile soft-shelled turtle, Trionyx triunguis. Zoo Biology, 15, 223-238.

This final study is a homage to turtles, an often-forgotten taxon of herpetoculture (not as bad as blind snakes though!). The study was very simple at its core – there was a turtle mutilating itself, the researchers gave it a ball and some pipe to play with, and….voilà! No more self-mutilation. The greater conceptual finding was that the turtle displayed a behavioural profile that indicated it was 'playing' with the objects it had been provided. I guess the real take-home message is that if you have an animal that is injuring itself, maybe a potential solution is to offer it enrichment opportunities (whether they be puzzle feeders, play objects, etc.) to stimulate its mind and end that repetitive behaviour.

'Snakes from enriched environments **grew much quicker,** exhibited **less stress** and had **superior problem-solving** abilities.'

A comment on the case studies and some tools for your kit.
So there is measurable evidence to suggest that improving reptile welfare through environmental enrichment has benefits including enhanced behavioural complexity and growth. Just as importantly, in my opinion, this presents an ideal avenue to advance the public image of captive keeping. Those that have tried to describe rack systems to non-reptile keeping friends may be familiar with the common comparison lay people draw of a puppy farm. I mean it basically makes sense to the everyday person; keep them in a small area and breed them for babies to sell. Remember, this is about public perception – I'm not attacking your keeping style, just trying to get you thinking!

The final section of this article will provide you with some ideas on how you can offer enrichment opportunities to your animals that replicate some of the challenges or stimulation that they may encounter every day in a wild setting:

Top left: *blue-tongue lizards will sometimes repeatedly attempt to climb the edge of an enclosure in captivity. Image by fivespots.*
Middle left: *Leopard Gecko. Image by Dobermaraner.*
Bottom left: *Steppes Ratsnake. Image by Vitalii Hulai.*
Above: *Nile Soft-shelled Turtle. Image by vblinov.*
Right: *water dragons may rub their noses in enclosures until they get oozing abrasions. Image by Jason Sulda.*

Mix up the diet.
Not only is dietary variety the key to good nutrition, but mixing up the diet is enriching! Offer the animals all sorts of bugs, grubs or vertebrates of different sizes. You may be surprised; very small lizards can spend a good amount of time subduing larger prey items (much like snakes) and it can be a challenge for them to get down….*enrichment!* Generally, if they can't swallow it they won't! If you feed dog foods or pre-mixes, try a few different brands or change the way you present the food to your lizards.

Alter feeding style.
For lizards there is evidence to suggest that slow-release feeding is much better at promoting behavioural diversity than typical scatter feeding. A simple, but effective slow-release feeder for lizards can be made by putting crickets in a transparent open-topped takeaway food container and then loosely sliding a second container on top. The crickets will slowly work their way out between the two containers and the lizards can snap them up. If the crickets decide to stay in the container it becomes a puzzle feeder; the lizards must separate the containers to be rewarded with food.

Move furnishings around.
Moving furnishings around helps animals to explore a newly-perceived environmental complexity. They may be in the same cage, but by changing the position of furnishings or providing new objects to investigate your reptiles can begin to form new associations within the environment. For snakes you can also mix up the shape, size and location (buried, arboreal, etc.) of hides. This also extends to mixing up the substrate you use, i.e. different types of sand, litter, commercial bedding, etc.

Varied climbing or perching objects.
A lot of species climb! Try offering your animal a rock, branch, statue, or whatever – you can even put some food at the top of the object. I've recently taken to making a mock nest for my snake to predate day-old chicks off an arboreal perch.

Varied thermal opportunities.
Wild reptiles don't exist in the homogenous bubble of a linear temperature gradient; they live in a true thermal mosaic! Modify your heating regime to give them some days that are slightly warmer or cooler, or change the position of the heat source (if possible). Obviously, you should manage this with care to make sure you're providing them with appropriate heat to survive. By extension, you can also vary the humidity for certain species – make sure to be aware of their natural climate.

Puzzle feeders.
Make getting food a challenge! Obviously, you want to ensure your animals have ample food to power their energetic needs, however you can make them hunt for it across their enclosures. Commercial puzzle feeders or home-made ones (PVC pipe with holes and caps) are a great option to present treat food items. Alternatively provide your reptiles with leaf litter to forage in, or logs that they must work food out of (for monitors in particular).

Scents to investigate.
Even simply throwing in shed skin from another species or aromatics like crushed eucalyptus leaves will provide stimulation for many animals. Some aromatics are thought to negatively impact certain reptiles, so do your research before you offer them to your pet.

'**Live plants** bring back a lot of the **complexity** that exists in the wild.'

Plants.
Plants, whether they be live planted or sacrificial, are a great addition to enclosures! Live planted enclosures change the game entirely and you get all manner of variations to your substrate, microclimates, etc. Essentially this brings back a lot of the complexity these animals have in their wild microhabitats. Sacrificial plants for omnivorous species on the other hand (i.e. parsley plants) are put in the enclosure knowing full well they will die. These guys still offer a bit of microclimatic variation for your herps, while also providing them with a tasty plant to try to tear leaves off!

Complexity.
Environmental complexity encompasses all of the above ideas and is the key to determining good welfare. This is where I think the enclosure size debate starts to creep in; with larger enclosures you can build more complex environments, but with that said just because you've got a bigger space that doesn't necessarily mean that you've set it up well! You can also have a huge enclosure with zero complexity – and that is going to have poor welfare outcomes.

I guess like most things in captive keeping, what I'm getting at is variety is the key. I suspect most people who read this article aren't going to go out and change many (if any) aspects of how they keep their reptiles. But wouldn't it be great if practices like offering your pet bearded dragon enrichment opportunities became commonplace in the hobby, rather than generalisations like red bulbs are good for dragons or sand is bad? It saddens me to say it, but in many ways the hobby has stagnated and we need to start pushing for interesting, exciting and novel changes to not only fix the issues we've whinged about for years, but also to improve captive husbandry techniques for current and future keepers and their animals. Get enriching!

Further reading:
This paper is open access (free) and has a tonne of interesting information:
http://inpractice.bmj.com/content/35/3/123

Above left: *this naturalistic enclosure has been specially constructed for Chameleon Geckos, and offers a high degree of environmental complexity. Image by Rob Porter.* ***Above:*** *likewise, this outdoor enclosure provides a complex environment for Green Tree Pythons. Image by Michael Cermak.*

What is venom?

Bianca op den Brouw is a PhD student at the Venom Evolution Lab, University of Queensland, where she is researching the venom of the Viperinae clade. She is involved in several additional venom-specific side projects, including studies on King Cobras and Australian elapids, and is President of the UQ Herpetological Society.

***Right**: using an unconventional form of delivery system, the Mozambique Spitting Cobra (*Naja mossambica*) can direct a spray of highly-potent venom with great precision over a distance of up to three metres. The eyes of the potential threat are deliberately targetted, and the venom can cause blindness or impaired vision. Image by Stuart G Porter.*

The problem with definition.

Venom. What is it, exactly? A few days ago, someone asked me that same question. Being an enthusiastic herper, you probably know the answer to that already, right?

"Easy," I hear you say. "A venom is injected; a poison is ingested." And you are right. Kind of. In reality, the definition of what makes a venom - or more precisely, what makes an animal venomous -- has been somewhat of a bone of contention within the scientific community, particularly across disciplines. So, if you are able to answer that question with anything short of a caveat-laden paragraph (or five), then you are doing better than many of the researchers who actually work with the stuff. So, what is it then?

A functional trait.

Venom is an adaptation which has evolved independently in almost every major animal group. There are venomous fish, cnidarians, invertebrates, mammals, and of course reptiles. In fact, you are probably never more than a stone's throw away from a venomous animal. The role of venom varies depending on the species, but it is usually employed in either a predatory or defensive context. This makes it a functional trait; a kind of evolutionary interface between organism and ecosystem, the use of which provides a direct contribution to the fitness of the venomous animal. This facilitated the explosive diversification of many of these venomous animal groups. That is, the emergence of venom ultimately gave these species a higher likelihood of success in adapting to and persisting in new and existing ecosystems, increasing their likelihood of survival and reproductive success.

Left: *the Bengal Slow Loris (*Nycticebus bengalensis*). There has been at least one fatality from a slow loris bite. Image by Hoang Mai Thach.*
Below right: *the venom of the blue-ringed octopus (*Hapalochlaena *spp.) contains tetrodotoxin, a potent neurotoxin that is also lethal if ingested. Image by kaschibo.*

The adaptive value of venom (the measure of its usefulness once delivered) is one of the key criteria for 'being venomous', and is probably the least contentious. For example, we humans have proteins in our oral secretions (saliva) which can also be found in venoms. We also have specialised glands that produce these secretions. However, the said secretions do not really offer us any adaptive value once out of our mouths. Therefore, we are not venomous.

'most snake venom toxins are derived from normal body proteins—digestive enzymes for example'

It is not yet understood precisely how, genetically, venoms were recruited as a biochemical weapon. However, DNA replication is an imperfect process, and mutations provide the perfect platform for the emergence of new, beneficial traits. Current research indicates that most snake venom toxins are essentially derived from normal body proteins - digestive pancreatic enzymes, for example - which, through some kind of genetic hiccup, were duplicated, expressed, and secreted by cells in oral glands, and were subsequently exapted and weaponised: delivered from one organism into the body of another, in which they exert a toxic effect.

Over time, selection favoured mutated forms of these molecules which induced their effects with greater power, speed, and/or efficiency. Specialised delivery systems were developed in parallel, such as venom glands coupled with fangs or stingers. Research points toward a similar mechanism of recruitment in some other lineages. For example, investigations are underway to demonstrate the homology between the proteins secreted by the skin's regulatory mucosal glands and those of the venom glands adjoining the spines in some species of catfish. This coupled 'venom system' is considered by many scientists to be a key aspect of differentiating between animals which *incidentally* introduce their oral secretions into the body of another organism and those that *actively* do so.

Ok, we are getting somewhere. So, to meet the criteria of being venomous, an animal must have specialised glands or cells which produce a toxic secretion that is administered into the body of the victim, via a wound, through the use of a specialised delivery mechanism? Well, sort of. Cue caveat number one. Heard of the slow loris (*Nycticebus* spp.)? This genus is considered by many to contain the world's only venomous primates. There are currently four described species, all of which are found in Southeast Asia. These nocturnal primates have brachial glands on their inner elbow that excrete a strong-smelling substance when they feel threatened. The slow loris licks this exudate, and the enzymes in its saliva break down and activate the toxins. The loris may bite defensively, thereby introducing the toxins to the animal that is the source of the threat.

However, neither the secretion nor the licking occurs the moment that the threat is perceived, but instead follow

many minutes later. Furthermore, the loris's teeth, though sharp and effective at penetrating flesh, are fairly typical for mammals which share its omnivorous diet, and thus are probably not specialised for the purpose of envenomation. And while there is at least one reported fatality from a slow loris bite, the responsible toxins are essentially allergens, the same type as those expressed by cats, and therefore exert limited toxic effect unless the victim has an anaphylactic reaction. To further complicate matters, the loris will also spread the exudate throughout its fur as a poisonous deterrent to ectoparasites and predators.

So, toxic secretion via specialised glands? Strictly, yes. Administered through the infliction of a wound? Partly, yes. Via a specialised delivery mechanism? Maybe. Venomous? Probably. Examples like these have led researchers - toxinologists, in particular – to broaden the definition of venom slightly by omitting the requisite for a specialised delivery system. When evaluating cases such as these, it is important to remember that evolution is a continuum. It is probably easier than you think to find examples of extant species which exist at stages all along the continuum from non-venomous to venomous, and perhaps the slow loris is one of them. So, at what point on this continuum do we actually class something as venomous? Good question. And how, then, does the composition of the toxic secretion come into play here? What actually *is* venom?

A complex cocktail.

Venom is, very simply speaking, a complex mixture of bioactive proteins and peptides. While there are also non-proteinaceous molecules in venoms, little is known about their specific function and it is thought that most of them perform some kind of housekeeping role. However, as this is not necessarily always the case, to be a bit more accurate we generally refer to the bioactive constituents of venom as toxins: molecules which can induce a toxic effect.

Molecular size and structure often differ categorically between a venom toxin and a poison toxin. Biological poisons are typically very small, organic molecules - that is, they are not usually proteinaceous - and their toxic effects can be experienced following ingestion, absorption, or inhalation of the poisonous substance. Venom toxins are usually comparatively large proteins whose activity relies on their structural integrity, which exposes active sites on the molecule. However, this also makes them fairly unstable. Any significant changes to structure - by heat, for example - results in a loss of toxin activity. This is called denaturation, and explains why the first aid treatment for a stingray sting is to immerse the affected

area in hot water. It is akin to what happens to the white of an egg when you boil it. Being proteinaceous, such toxins are also easily broken down by the digestive system, hence the ability to drink snake venom with little ill effect - unless of course you have any lesions in your mouth or oesophagus (do NOT try this at home!).

So venom is a complex mixture of large, mostly proteinaceous compounds that are only toxic if delivered directly into a victim's tissue? Well, nearly. Cue the deadly blue-ringed octopus (*Hapalochlaena* spp.). While the powerful venom of these tiny cephalopods is primarily used for predation, it is infamous in its ability to drop a human within as little as 15 minutes after being bitten. This is thanks to a potent neurotoxin called tetrodotoxin. However, tetrodoxton is a small, non-proteinaceous molecule that is also lethal if ingested, meaning that it is both a venom and a poison, depending on the mode of delivery.

While it is possible to generalise regarding the differences in biochemical characteristics of most venom toxins versus most poison toxins, the former are actually defined by their mode of delivery and the functional role they serve within the victim's body, together with their chemical properties. So just how do toxins work once injected?

Potent precision.

As the active site of a venom toxin is of a very specific configuration, it follows intuitively that toxins have distinct molecular targets in the victim's body. That is, a given toxin type will target a specific cell receptor or protein, for example, following the 'lock-and-key' metaphor. Venom toxins usually target cells and molecules that have some kind of regulatory role, for example the regulation of bleeding (haemostasis) or neurotransmission. Each of these processes is regulated by numerous different receptors, cells and molecules; for example, there is not a single protein which regulates bleeding, but dozens.

All of these regulatory processes are collectively referred to as homeostasis - the maintenance of stable and optimal conditions - and toxins work by upsetting the homeostatic balance. This could be by inhibition (such as a neurotoxin which blocks nerve signals to induce paralysis), or it could be via stimulation (such as a coagulotoxin which activates proteins in the blood to induce rapid and extensive clotting).

While we commonly categorise venoms based on which homeostatic process they disrupt - that is, which pathology they induce (neurotoxic, haemotoxic, cytotoxic, etc.) - this actually tells us very little about the toxin itself. Toxins are instead classed by their structural scaffold; their core structure. Their domains, however - their active sites - vary from toxin to toxin, and this is what determines their molecular target and activity. Think of it as classing cars based solely on their type of engine, where varying the tyres, shell, and overall size of the car will determine its performance. Stick a 5.7L V8 engine into a VW Beetle and it will drive pretty differently than the same engine in a Toyota Landcruiser fitted with Mickey Thompsons – and I dare say that the two cars would be likely to be driven to different destinations. Along the same lines, one type of snake venom metalloprotease (SVMP), for example, may activate a specific protein which induces clotting, while another SVMP may destroy proteins to cause haemorrhage. Furthermore, a toxin's activity will peak under its own set of optimal conditions, such as a specific temperature and pH - favourable track conditions, if you will.

Above: *the Inland Taipan or Fierce Snake (*Oxyuranus microlepidotus*) possesses by far the most potent venom of any snake. Its venom is specifically adapted to target mammals, but human bites are extremely rare, due to its remote distribution and shy temperament. Image by Susan Schmitz.*

Because of the diversity in toxin type and activity, as well the plethora of regulatory molecules maintaining homeostatic processes, identical pathologies could be induced by totally different toxins acting on different molecular targets. For example, neurotoxicity could be induced by a three-finger toxin (3FTx) blocking a given nerve cell receptor, or by a phospholipase (PLA_2) breaking down the structural lipids of skeletal muscle cells – two very different toxins with different precise targets, but the same pathological outcome: paralysis. Different roads being driven by different cars, but arriving at the same destination.

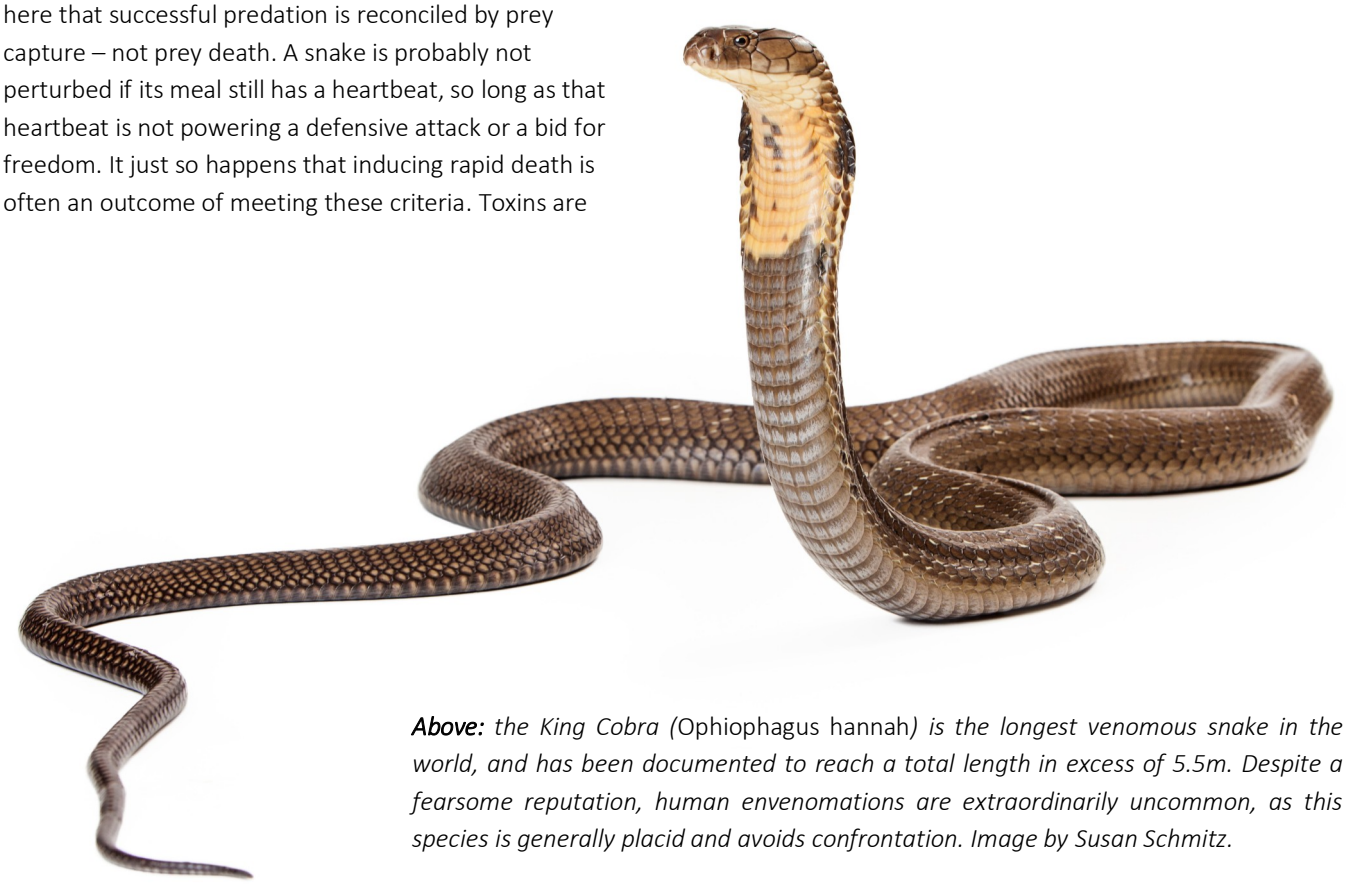
A biochemical weapon.

While the role of venom varies between taxa, the primary function of venom in snakes is for use in predation. A snake's venom does not just have one type of toxin. While there are many species whose venom is dominated by a specific toxin family, it is common for a venom to be composed of dozens, if not hundreds, of different toxin types belonging to over a dozen protein families. These toxins work together, synergistically, to facilitate efficient prey capture. It is important to note here that successful predation is reconciled by prey capture – not prey death. A snake is probably not perturbed if its meal still has a heartbeat, so long as that heartbeat is not powering a defensive attack or a bid for freedom. It just so happens that inducing rapid death is often an outcome of meeting these criteria. Toxins are thus likely to be selected for on this basis: the ability to efficiently immobilise prey, where efficiency is measured by both predation success and energy conservation. At a molecular level, efficiency is dictated by the affinity of toxins for biochemical targets within prey and their efficacy in disrupting physiological pathways.

'it is common for a venom to be composed of dozens, if not hundreds, of different toxin types'

The physiological parameters between different animals' bodies can vary substantially, depending on the organism and its environment. Blood chemistry, body temperature, and neurone configuration will differ substantially between a lizard, a bird, and a fish, for example. This means that the specific cell types, receptors, and proteins servicing these body processes will also differ. It is therefore probable that positive selection would favour toxins with high affinity and efficacy for their preferred prey's molecular physiology.

When looking at the proteome (protein composition) of snake venoms, there is an observable trend emerging to suggest that venom composition is indeed evolving to become more specific to the physiology of the prey taxa which comprise respective snake species' diet. Snake venoms often vary intraspecifically as an apparent reflection of differences in diet and feeding ecology. For example, it is not uncommon for the diet - and venom - of a given snake species to vary between populations, according to the prey items that are locally available. This is often observed in species whose distribution covers a



Above: *the King Cobra (*Ophiophagus hannah*) is the longest venomous snake in the world, and has been documented to reach a total length in excess of 5.5m. Despite a fearsome reputation, human envenomations are extraordinarily uncommon, as this species is generally placid and avoids confrontation. Image by Susan Schmitz.*

broad geographical area. The diet of a snake may also change ontogenetically, and age-related shifts in venom composition are also common in such species.

In parallel, due to the evolutionary pressure exerted on animals which are heavily predated upon by venomous snakes, or indeed predate upon venomous snakes, many such species evolve resistance. For example, populations of ground squirrels which are heavily predated upon by rattlesnakes are able to tolerate significantly higher doses of venom than are populations of their conspecifics which inhabit areas absent of these viperine predators. There are multiple ways in which resistance can develop; for example through the evolution of a molecule which is able to inhibit a toxin's activity, or through mutations which render a target molecule unrecognisable to a toxin.

These selective pressures exerted reciprocally by predator and prey drive an 'evolutionary arms race': the evolution of a trait in one driving the evolution of a trait to counter it in the other. However, as something of a trump card, many snakes possess toxins in their arsenal which have evolved to target conserved molecules in their prey. A conserved molecule is one that has remained unchanged over long periods of evolutionary time – and for good reason. Typically, such molecules play an essential role in homeostasis. Therefore, if the coding gene mutates in a manner that would render the molecule unrecognisable by the toxin, it most likely also changes the molecule's ability to carry out its vital function. This is a deleterious mutation, harmful to the organism, and therefore that mutation - and the resistance it may have conferred - will not persist in the population.

So, what is venom?

Ok. So, with a few tangents and caveats along the way, we have reached the most parsimonious definition agreed upon by many scientists:

*'Venom is a toxic secretion that is produced by specialised glands or cells of one animal and delivered (*usually *via a specialised delivery mechanism) to another animal, through the infliction of a wound, which disrupts the normal physiological processes of the receiving animal and benefits the producing animal.'*

Right? Well, sorry to disappoint you so close to the finish line. Cue antimicrobial peptides (AMPs for short). AMPs are very small proteins (peptides) which are part of the defensive mucosal skin secretions of many amphibians: there is no specialised delivery system, and they are toxic if ingested, so there is little contention surrounding the classification of such frogs as poisonous. But researchers investigating the role of AMPs found that they have a mechanism of action which blurs the line between venom and poison. Once ingested, they essentially act as microscopic corkscrews, drilling tiny holes into cell walls to facilitate the entry of the other toxins into cells and tissues. Perhaps it could even be argued that the AMPs *are* the specialised delivery system.

So, what is venom? Venom is a human construct; our attempt to label a complex array of similar evolutionary strategies against the will of Mother Nature, who, in her indifference, reveals herself to be a rebellious teenager, defying our attempts to neatly define her ways.

Above: *the Gaboon Viper (*Bitis gabonica*) has the longest fangs of any venomous snake – up to 5cm in length. It also has the highest venom yield, with enormous venom glands capable of delivering 5-7ml in a single bite. The venom itself, however, does not rate as exceedingly toxic, and humans are very seldom bitten, as these snakes are exceptionally docile and confined to rainforest habitat. Image by Eric Isselee.*

Antivenom.

As a post script to her article on venom, Bianca op den Brouw looks at how antivenom works, and why is it so difficult to achieve a 'broad-spectrum' antivenom?

Image by Chuck Rausin.

Antivenom is produced by injecting a host animal, such as a horse, with increasing amounts of a given venom (or venoms) over time. The venom toxins are present in quantities small enough that they do not cause too much harm, though they are still detected by the animal's body as foreign molecules, or antigens. This triggers a response in the immune system of the host animal, inducing the production of antibodies.

Antibodies are proteins which are able to recognise an antigenic 'epitope': a face, of sorts - a molecular site unique to that antigen. Each type of antibody is essentially only able to recognise one face - one epitope - and therefore an antibody is said to be specific to an antigen. This is why multiple vaccines are required for immunisation against the influenza virus – each mutated form of the virus has a different epitope. The ability to recognise epitopes with such high specificity is what enables the immune system to differentiate foreign molecules from normal body molecules. Once an epitope is recognised, the specific antibody will then bind to the antigenic toxin which, depending on the toxin structure, either neutralises its harmful activity on the body, or acts as a flag to immune cells to locate and destroy it.

As the bioactivity and structure of the numerous toxins composing venom differ, each toxin type has different antigenic properties and a different epitope. Therefore, each toxin type stimulates the production of toxin-specific antibodies by the host animal's immune system. This cocktail of antibodies is then extracted and purified from the blood of the host animal, and the resulting mixture is used as an antivenom. The composition of the antibodies comprising an antivenom is therefore specific to the venom or venoms used during the antivenom production. This is why different antivenoms are needed for different species of snake. This is also why variation in venom composition within a single snake species can seriously compromise the effectiveness of an antivenom.

Further, as the immune response does not discriminate between antigens, antibodies are produced for all components of venom, regardless of how much harm they are capable of inducing. Therefore, if too many different venoms are used to produce an antivenom, the essential antibodies are diluted by the presence of non-essential antibodies, thus requiring substantially more antivenom to achieve the same effect.

Left: *an Irula tribesman milks a snake for antivenom production at the Madras Croc Bank. The Irula Co-op will feature in an upcoming article. Image courtesy Madras Croc Bank.* ***Below:*** *variation in venom composition can seriously compromise the effectiveness of antivenom. Image by Michael Cermak.*

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LL2015 - 15W	LL5015 - 15W	LL1015 - 15W
LL2025 - 25W	LL5025 - 25W	LL1025 - 25W
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Photograph courtesy of Rochelle James