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Did you see the welcome news that Amazon boss Jeff Bezos has pledged a staggering \$10 billion (about £7.7 billion at the current exchange rate), with the aim of helping to safeguard the Earth for future generations? Known as the Bezos Earth Fund, this donation represents almost 8 per cent of his estimated wealth, derived from the company that he founded at the start of the internet era in 1995.

It's a serious amount of money - and Bezos has indicated that this may only be the start of his investment in saving the planet. The first payments for projects will begin this summer, although exact details of what the funds will be spent on have yet to be confirmed. Bezos's world view fits alongside the massive donations made by fellow computer entrepreneur, Bill Gates and his wife Melissa, who have invested hundreds of millions of dollars in aiming to eliminate malaria.

What sets these donations apart from those given by governments is that both men have been hugely successful - Bezos ranks as the wealthiest man on the planet - and their entire business careers have been built on delivering success. They have unparalleled management skills to bring about the change that is needed, in terms of co-ordinated planning to achieve the right outcomes.

It will be very interesting to see just how the Bezos Earth Fund spends its money, but you can be sure that those in charge will be experienced and tasked with delivering positive and measurable results. There is a message for the UK government here as well, when assessing how to spend its annual foreign aid budget, which is approximately twice that of the sum set aside by Jeff Bezos.

Surely, foreign aid spending should be targeted much more these days towards benefiting the environment, and thus not only helping people, but also the planet? A strategy of this type needs to be right at the heart of any spending decisions that are made with this public money.

There are a host of projects that could be set up and run to provide both local employment and assist conservation work in what are often (but not always, in the case of India) poor countries with growing human populations that have little money to spend on conserving their own natural resources. Many species of reptile and amphibian could then benefit as a result, if their habitat was not being destroyed.

This type of approach could also be combined with captive-breeding centres producing stock for release, to boost the numbers of vulnerable species in areas where suitable habitat is being regenerated again. There could then be human benefits too. More frogs would consume larger numbers of mosquito larvae and adult mosquitos, and in turn, this would naturally help to control the malarial parasite, revealing the overlap between what these internet entrepreneurs are seeking to achieve with their money.

David Alderton

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David has extensive practical experience with this group of creatures, going back over 40 years. He has written and broadcast widely about their care and biology.



Contents

Features

22 HOGNOSES – discover why these particular snakes have grown significantly in popularity over recent years, and also find out what is involved in caring for and breeding them successfully.

28 INTRODUCING TORTOISES – the origins of today's tortoises can be traced back as far as the late Triassic period, around 200 million years ago. Discover how they have changed since then, along with their distribution.



30 TRAINING YOUR REPTILE – reptiles and even amphibians are now known to be surprisingly responsive to training. Techniques of this type are being used to help veterinary examinations in zoos for a range of species today, ranging from crocodilians to dart frogs. Dr Julia Mueller-Paul reveals just how you can train your reptiles, giving a step-by-step guide in the case of a tortoise.

38 THE FORGOTTEN KING – the Florida kingsnake (*Lampropeltis getula floridana*) has tended to be overlooked in the past, compared with its popular west coast relative, the California kingsnake (*Lampropeltis g. californiae*) and the mountain kingsnake (*Lampropeltis pyromelana*). But could things now be changing?

40 ALL THE KING'S COLOURS – a detailed insight into the world of Florida kingsnake morphs, revealing the opportunities that these snakes now offer for breeders.

44 STYLING COUNTS – when it comes to deciding how you want to decorate your vivarium, there are various factors to bear in mind - but most importantly, the needs of the species that you are keeping should be uppermost in your thoughts, advises Greg Jennings.

46 UNDERSTANDING METABOLIC BONE DISEASE – as the number of reptiles kept as pets has increased, so too has the frequency of husbandry-related illnesses. Although it is easy to blame this situation on basic ignorance or misunderstanding of specific care requirements for particular species, the situation can be more complicated, as is explained here.

50 WHY NOT CONSIDER WHITE'S? – this is a great tree frog to start out with, possessing a friendly, docile personality, combined with a cute dumpy appearance, and it is also easy to maintain.

Regulars

4 NEWS AND VIEWS – featuring stories this month about how technology is helping to track the distribution of turtles more efficiently than ever, the remarkable recovery of a new fossil reptile from the sea in Alaska, the future for fireflies in the world today, monitoring the movements of box turtles, new species of lizard and more, starting with the discovery of the world's largest turtle.

16 LIZARD COMMUNICATION – in his *Out Of Africa* column this month, zoologist Paul Donovan looks at the varied range of ways in which lizards communicate with each other, and even in some cases with us as well.

34 REPTILE FOCUS – stunning photography of a colourful reptile in close-up.

36 Q & A – addressing the problems that you want answered.

54 HERPETOLOGICAL MYSTERIES – in the first of a two part mini-series, Dr Karl Shuker investigates the possibility of the existence of gigantic spiders living in the US state of Louisiana, with this information being published here exclusively for the first time.

59 PUZZLES – test your knowledge with our range of reptile-related puzzles.

61 YOU AND YOUR REPTILES – a great selection of the photos that you've sent in. Why not try your hand at taking some pictures of your pets, email them to us and hopefully see them in the next issue, possibly winning a prize as well?

64 SUBSCRIPTION OFFER – AND BACK ISSUES.
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66 NEXT MONTH – and also how to contact us.

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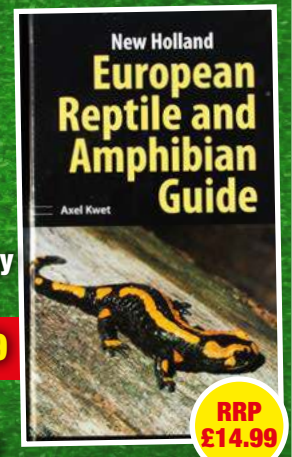
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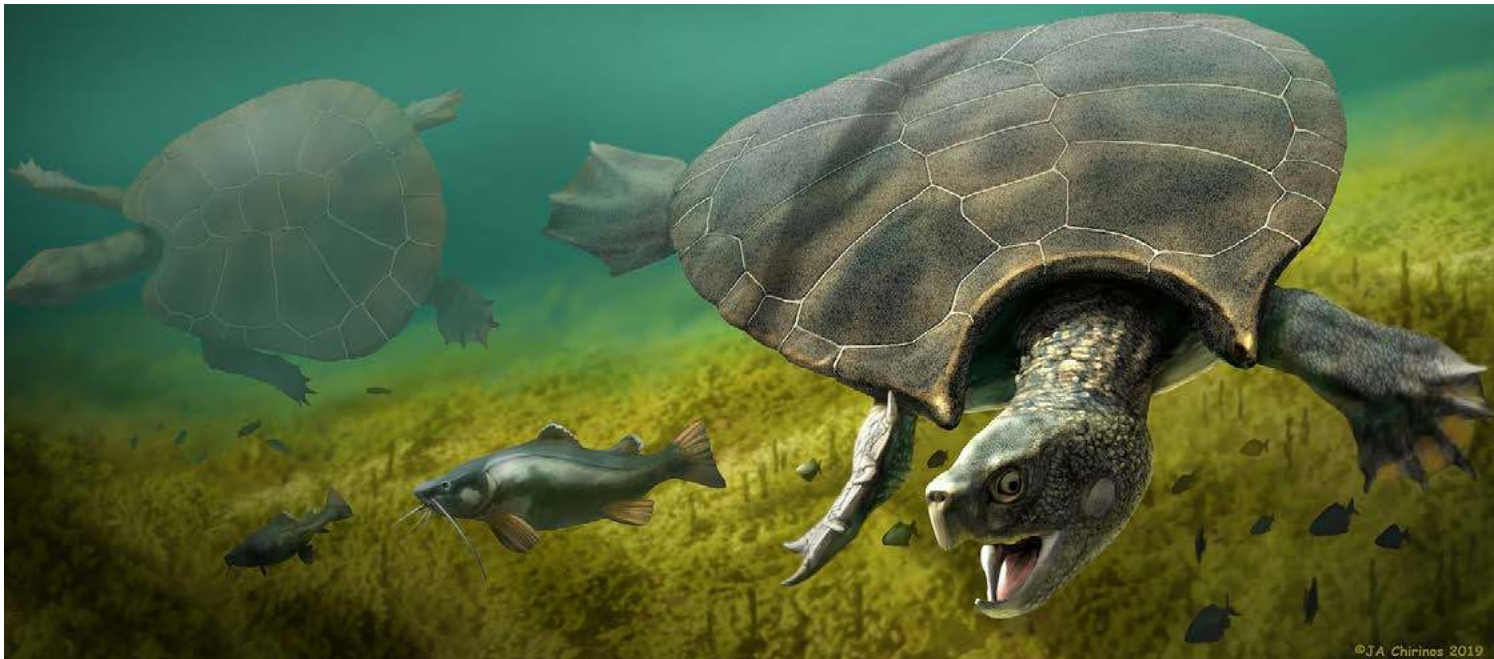
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Biggest turtle on record discovered in South America



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Scientists have discovered truly gigantic specimens of an extinct freshwater turtle known as *Stupendemys*. The carapace of this turtle, which is the largest ever known, can measure between 2.4-3 metres (7.8-9.8ft). Moreover, the shell of male *Stupendemys* had horns, which is a rare feature in turtles.

The tropical region of South America is one of the world's hot spots when it comes to animal diversity. The region's extinct fauna is unique, as documented by fossils of giant rodents and crocodilians – including crocodiles, alligators, caimans and gavials – that inhabited what is today a desert area in Venezuela. Some five to 10 million years ago, however, this was a humid swampy area teeming with life. Amongst its inhabitants was *Stupendemys geographicus*, a turtle species that was first described during the mid-1970s.

A true giant

In this latest study, a team of researchers, from the University of Zurich (UZH) in Switzerland and others from Colombia, Venezuela, and

▲ **Reconstruction of the giant freshwater turtle *Stupendemys geographicus*: with a male (front) and female individual (left) seen here swimming.** Artwork courtesy Jaime Chirinos.

► **Venezuelan palaeontologist Rodolfo Sánchez uses his body to highlight the size of the carapace of a male *Stupendemys geographicus*, found in deposits in Venezuela that are eight million years old.** Photo courtesy Edwin Cadena.



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Brazil, has discovered exceptional specimens of this extinct turtle in new locations across Venezuela and Colombia. "The carapace of some *Stupendemys* individuals reached almost three metres or 10 feet, making it one of the largest, if not the largest turtle that ever existed," explains Marcelo Sánchez, director of the Paleontological Institute and Museum of UZH, who led this study.

This turtle had an estimated body mass of 1145kg (2524lb) – equivalent to 22.5cwt, or approximately the weight of a small car. *Stupendemys* weighed almost 100 times more than of its closest living relative, which is the big-headed Amazon river turtle (*Peltocephalus dumerilianus*).

Males carried horns on their carapace

In some individuals, the complete carapace showed a peculiar and unexpected feature: horns. "The two shell types indicate that the sexes of *Stupendemys* were clearly recognisable – males had horned shells, while females lacked this distinctive feature," says Sánchez. "This is the first time that sexual dimorphism in the form of horned shells has been reported for any of the side-necked turtles, which represent one of the two major groups of turtles worldwide."

Despite its tremendous size and the protection afforded by its shell, the turtle still had natural enemies. In many areas, the range of *Stupendemys*

▲ The big-headed Amazon river turtle is the closest living relative of *Stupendemys*, but is minuscule in comparison, growing no larger than 50cm (20in) in length.

Photo courtesy guentermanaus/www.shutterstock.com

coincided with that of *Purussaurus*, the largest of all caimans. They too were giants, growing to a length of at least 11m (36ft) and weighing as much as 5.6 tonnes (6.2 tons). These huge crocodilians were the most likely predators of the giant turtle, given not only their size but also their feeding habits. Further supporting evidence comes from the appearance of bite marks and punctured bones in the fossilised carapaces of *Stupendemys*.

Turtle phylogeny thoroughly revised

Since the scientists also discovered jaws and other skeletal parts of *Stupendemys*, they were able to revise the evolutionary relationships of this species thoroughly within the turtle tree of life. "Based on studies of the turtle's anatomy, we now know that some turtles from the Amazon region represent its closest living relatives," explains Sánchez. "Furthermore, the new discoveries and the investigation of existing fossils from Brazil, Colombia and Venezuela indicate a much wider geographic distribution for *Stupendemys* than had been previously assumed. This giant reptile ranged right across the whole northern part of South America."

◀ Rodolfo Sánchez pictured with the carapace of a male *Stupendemys geographicus*. The projecting 'horns' are evident here at the front of the shell.

Photo courtesy Jorge Carrillo.



Further reading

E-A. Cadena, T. M. Scheyer, J. D. Carrillo-Briceño, R. Sánchez, O. A. Aguilera-Socorro, A. Vanegas, M. Pardo, D. M. Hansen, M. R. Sánchez-Villagra. **The anatomy, paleobiology and evolutionary relationships of the largest side-necked extinct turtle.** *Science Advances*, 2020. DOI: 10.1126/sciadv.aay4593

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New species found in 2019

During 2019, researchers based at the California Academy of Sciences added a remarkable 71 new plant and animal species to the world's family tree, enriching our understanding of Earth's complex web of life and strengthening our ability to make informed conservation decisions. The new species include 17 fish, 15 geckos, eight flowering plants, six sea slugs, five arachnids, four eels, three ants, three skinks, two skates, two wasps, two mosses, two corals, and two

lizards. More than a dozen Academy scientists—along with many more international collaborators—were directly involved in describing these new species.

Restricted ranges

Academy Research Associate Dr Aaron Bauer has described more than 205 reptiles during his career, and in 2019, he added another 15 mottled day geckos, three island-dwelling skinks, an ostentatiously orange lizard, and a high-altitude girdled lizard to the list of known species. Bauer recommends that many of these reptiles should be listed as critically endangered, because of their microendemism—a term used to describe species only found within an extremely small geographic range.

This restricted distribution means that these animals are particularly susceptible to any sort of disturbance, such as deforestation. In the case of the newly described skink, christened *Kuniesaurus albiauratus*, invasive fire ants already threaten its restricted, native habitat on the Pacific island of New



▲ A newly-discovered species of cave-dwelling harvester spider from Croatia found last year, now christened *Lola konavoka*.

Photo © R. Ozimec.

Caledonia. Bauer argues that finding these microendemic species is crucial for conservation. "If we don't explore isolated habitats, like mountaintops, we would miss a huge part of the biodiversity that is totally unique to these regions," he explains.



▲ Another previously-unknown South African lizard, which is now called the N'Dolondolo girdled lizard (*Cordylus phonolithos*). Its body is protected by the bony plates evident here, called osteoderms. Photo © 2019 Ishan Agarwal.



▲ A limestone area of dense coastal forest on the Île des Pins, located off the southern tip of New Caledonia, is home to a unique island skink, known as *Kuniesaurus albiauratus* which is considered to be critically endangered, although it was only recorded for the first time last year.

Photo courtesy Jeremy Red/www.shutterstock.com



▲ The Lambert's Bay sandveld lizard (*Nucras aurantiaca*) is a new species of wall lizard discovered by Dr Aaron Bauer in South Africa.

Photo © 2019 P. leFras and N. Mouton.

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Axolotl sheds light on regeneration



The axolotl, with its large gills and widely-spaced eyes, has a certain alien look, which is reinforced by its truly remarkable powers of regeneration. If it loses a limb, part of its heart or even a large portion of its brain, it's not a problem: remarkably, it all grows back. "Axolotls regenerate almost any part of their body after almost any injury that doesn't kill them," explains Parker Flowers, based at Yale University at New Haven, in the US state of Connecticut.

If scientists can gain a clear understanding into the genetic basis for the axolotl's phenomenal ability to regenerate, they might be able to find ways to restore damaged tissue in humans. But they have been

thwarted in this attempt by another peculiarity of the axolotl — it has the largest genome of any animal yet sequenced. In fact, its genetic code is 10 times larger than that of humans.

Unravelling the genetic information

Now Flowers and his colleagues have found an ingenious way to circumvent the animal's complex genome, and have managed to identify at least two genes involved in regeneration. The advent of new sequencing and gene-editing technologies has allowed researchers to craft a list of hundreds of gene candidates that could be responsible for the regeneration of limbs.

However, the huge size of the

▲ **Axolotls can regenerate not just lost limbs, but also internal organs too - even much of the brain! They are in fact tadpoles (of a salamander) which display the phenomenon of neoteny, meaning they are able to reproduce in an immature form. In fact, they typically spend their entire lives as tadpoles, and never undergo metamorphosis.**

Photo courtesy Enri/www.shutterstock.com

axolotl genome populated by vast areas of repeated stretches of DNA has made it difficult to investigate the function of those genes.

The team used gene editing techniques in a multi-step process essentially to create particular markers that could track 25 genes suspected of being involved in limb regeneration. The method allowed them to identify two genes in the blastema — a mass of dividing cells that form at the site of a severed limb — that were also responsible for partial regeneration of the axolotl tail.

Flowers emphasises that many more such genes probably exist. Since humans possess similar genes, the researchers say that scientists may ultimately discover how to activate them, in order to help speed wound repair or regenerate tissues in ourselves.

➤ **Getting to grips with the axolotl's complex genetic code required some pioneering genetic work.**

Illustration courtesy DmitryRazinkov/www.shutterstock.com



Further information

Lucas D Sanor, Grant Parker Flowers, Craig M Crews. **Multiplex CRISPR/Cas screen in regenerating haploid limbs of chimeric Axolotls.** *eLife*, 2020; 9 DOI: 10.7554/eLife.48511



▲ **An axolotl in close-up.** Photo courtesy Lapis2380/www.shutterstock.com

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Box turtle insights

Ohio University researchers set out to determine the impact of the Route 33 bypass through Wayne National Forest on the local box turtle population. The answers that they discovered were not exactly what they expected...

Roads nowadays seem to run almost everywhere. They define the very fabric of our societies, and very few places in North America remain free of them. As an integral part of the landscape, roads and the traffic that they convey also have unintended consequences for wildlife: many animals die as a result of vehicle strikes, and some of these collisions also pose a risk to human lives—think about the consequences of hitting a moose, bear or deer on the highway at 110 kph (70 mph).

These types of events capture a lot of attention, and management agencies work hard to minimise the chance of wildlife-vehicle strikes through planning mitigation structures such as wildlife fences and overpasses into the design of highways.

However, the impact of roads on wildlife is not limited to animals dying in collisions with vehicles. Roads may affect the way in which animals use their habitat. They may bisect important connections between habitats and populations,

or they may deter animals altogether and increase their stress levels because of traffic noise, light or vibration. Marcel Weigand, working in Dr. Viorel Popescu's Conservation Ecology Lab at Ohio University recently investigated these impacts.

Endangered by road mortalities

With a passion for reptiles, Weigand set out to study how new high-traffic roads affect the ecology, behaviour and physiology of eastern box turtles (*Terrapene carolina carolina*), a species of concern in Ohio as it is threatened by road mortality. Weigand found the perfect study setting, in the guise of the new Nelsonville Bypass (Ohio Highway 33), cutting through Wayne National Forest, and opened to vehicle traffic in 2013. Several other wildlife studies have been under way in the same location, investigating the success of mitigation structures to reduce road mortality for deer, snakes, and amphibians, so focusing on turtles would paint a more complete picture on the effects of the new highway on road-naïve wildlife.

Weigand also scouted a roadless study site, not far from the bypass, on the Hocking College and Wayne National Forest lands; this would serve as a control test site, against which any potential effects of the



▲ A box turtle crossing an unpaved road in the Wayne National Forest.

Photo courtesy Ryan Wagner.

bypass could be compared. Then, over the course of two years, Weigand, aided by a horde of undergraduate Ohio University and Hocking College students, tracked 30 of these box turtles: 15 along the bypass and 15 at the roadless site. They used VHF (= very high frequency) telemetry on a daily basis between March, when turtles come out of hibernation, and October, when they dig down deep for their long winter sleep.

The team first captured and collected the turtles with the help of turtle detection dogs, specially trained to sniff out and find these reptiles even under feet-deep leaf litter. After attaching a small transmitter that would provide data on their movements and habitat use, all turtles were treated to a pedicure, in the name of science, of course!

By clipping a couple of millimetres

◀ Marcel Weigand (left) and Christine Hanson (right) handling a box turtle during telemetry surveys, tracking individual movements of these reptiles.

Photo courtesy Ben Siegel.



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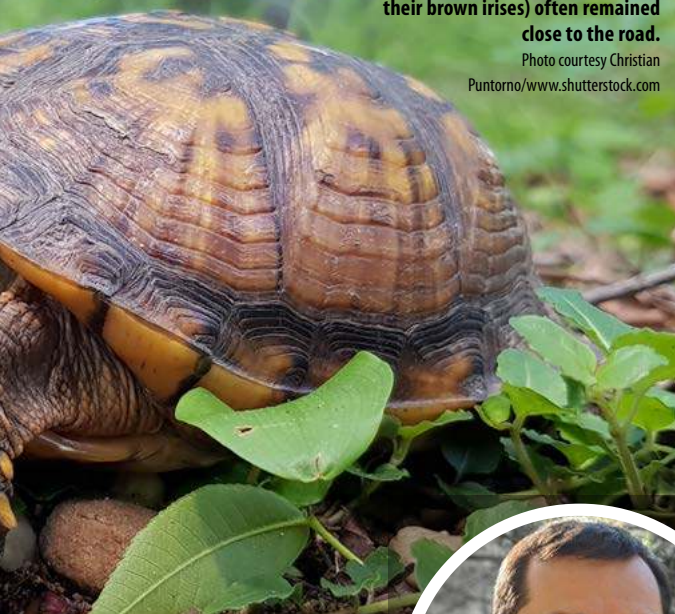
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Female box turtles (recognisable by their brown irises) often remained close to the road.

Photo courtesy Christian Puntorno/www.shutterstock.com



of their nails, the OHIO researchers could learn about their stress levels in the previous several months, as the stress hormone corticosterone accumulates in the nail keratin. To evaluate corticosterone levels, Weigand forged a collaboration with Ohio State University avian ecologist and physiologist Dr. Chris Tonra, with his new endocrinology lab offering the equipment and expertise for performing state-of-the-art hormone bioassays.

"Tracking turtles was hard, but fun work! It turns out that turtles liked to hang out (a lot) in fun places like thick patches of greenbrier and roses, with sharp thorns," says Weigand. "Overall, we found that turtles at both roadless and roadside sites used similar habitats, with high volumes of downed woody debris and thick understory, so our initial hypothesis that the bypass was affecting how turtles selected habitat was not validated."



▲ Dr. Viorel Popescu.

Photo courtesy Dr. Viorel Popescu.

▼ Marcel Weigand tracking box turtles via VHF telemetry.

Photo courtesy Ben Siegel.



No crosses

However, the researchers discovered something rather puzzling: while many turtles used the open roadside habitat created by the new highway for thermoregulation and nesting, with several female turtles spending many weeks during summer within a few feet of the pavement, no turtles attempted to cross the road!

"We were confident that we would see some crossing attempts, as box turtles crossing roads are a common sighting in this part of Ohio.

Instead, the new highway acted as a complete barrier to turtle movements; so, in the absence of crossing structures, such as underpasses, the highway has the potential to separate the local box turtle population completely," warns Dr Viorel Popescu.

"Interestingly, a four-foot (=1.2m) wide culvert underneath the highway was available to the bypass group of turtles, enabling them to reach the other side, but no turtle accessed this mitigation structure. Cutting gene flow in this way may have long-term negative impacts on the viability of turtle populations and will decrease their ability to cope with other threats."

Another unexpected result was the lack of a difference in nail keratin corticosterone concentrations between the turtles at the bypass and roadless sites. "This came as a surprise, as we expected that the road-naïve population along the bypass would exhibit higher stress levels due to proximity to the busy highway; yet corticosterone levels were not higher even in individuals that spent weeks in very close proximity to the highway," adds Weigand. "This result, along with the lack of differences in habitat use and home range sizes, show that box turtles have the capacity to adapt rapidly to new habitat conditions."

The appeal of survey work

Weigand's study also offered the opportunity for many OHIO and Hocking College undergraduates to learn new field skills, such as VHF

telemetry, habitat sampling and field data collection, GPS orientation and much more. Ryan Wagner, a Wildlife and Conservation Major supported by OHIO's Program to Aid Career Exploration (PACE), was Marcel's sidekick throughout the study. "This was my first exposure to wildlife field research, and it gripped me! I love reptiles, and having the opportunity to participate in all aspects of this study, from capturing, tagging and tracking turtles, to stress hormone lab work, data analysis and manuscript writing, set the stage for my next career move, to graduate school," he says enthusiastically.

Conclusions

Overall, this study opens up many other questions about the long-term impacts of barriers on the genetic makeup of turtle populations, their physiology, as well as their population viability. It suggests wildlife management techniques that could make certain areas more attractive to turtle populations without putting them at risk of exposure to roads.

It also highlights the importance of designing and implementing types of road mitigation structures that will maintain population connectivity. "This research is a prime example of what collaboration can achieve: in this case between academia, Wayne National Forest, Ohio Department of Transportation and local environmental groups (Rural Action). My hope is that our work will provide transportation and wildlife management agencies with additional knowledge and tools to ensure that our perceived progress does not rest on the backs of turtles!" says Weigand.

Further information

Nicole M. Weigand, Ryan B. Wagner, Christopher M. Tonra, Viorel D. Popescu. **Proximity to highways has limited influence on space use and physiology of terrestrial testudines.** *European Journal of Wildlife Research*, 2019; 65 (5) DOI: 10.1007/s10344-019-1315-1

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Computer model tracks turtle hatchlings

A team of Florida researchers and their collaborators have created a first-of-its-kind computer model that tracks where sea turtle hatchlings go after they leave Florida's shores. This is now giving scientists a new tool to figure out where young turtles spend their "lost years."

Nathan Putman, a biologist with LGL Ecological Research Assoc. based in Texas, led the study, which included 22 collaborators across Mexico, the southeastern United States, the Caribbean, and Europe. Co-authors include UCF Associate Professor Kate Mansfield, who leads UCF's Marine Turtle Research Group, and UCF assistant research scientist Erin Seney.

"The model gives community groups, scientists, nonprofit agencies and governments across borders a tool to help inform conservation efforts and guide policies to protect sea turtle species and should help to balance the needs of fisheries and other human activity," Putman explains. "It is built to predict loggerhead, green turtle and Kemp's ridley abundance."

Massive data input from numerous sources

In order to create the model, the team looked at ocean circulation data over the past 30 years. These data are



▲ Much still remains to be discovered about what happens to young sea turtles in their crucial early years after they enter the sea for the first time. This new tracking model helps to supply the answers. Photo courtesy Kjersti Joergensen/www.shutterstock.com

known to be reliable and routinely used by National Ocean and Atmospheric Administration and other agencies. The team also used sea turtle nesting and stranding data from various sources along the Caribbean, Gulf of Mexico and Florida coasts. The dataset includes more than 30 years of information from

UCF, which has been monitoring sea turtle nests in east Central Florida since the late 1970s. In fact, Mansfield, Seney and Putman had previously worked together on other sea turtle studies in the Gulf of Mexico.

"The combination of big data is what made this computer model so robust, reliable and powerful," Putman says. "We then used U.S. and Mexican stranding data—information about where sea turtles washed ashore for a variety of reasons—to check if the computer model was accurate."

Although the model also accounts for hurricanes and their impact on the ocean, it does not take into consideration man-made threats such as the 2010 Deepwater Horizon oil spill in the Gulf of Mexico, which occurred during the years analysed in the study."

The critical "lost years"

The computer model predicts where the turtles go during their "lost years" – a period after the turtles break free from their eggs on the shoreline and head into the ocean in the Gulf of Mexico and northwest Atlantic. The turtles spend years among sargassum in the ocean, and any data concerning that period of time is

Input about records of stranded sea turtles forms part of this new programme, adding to its accuracy. Photo courtesy Dario De Dobbelaere/www.shutterstock.com



A sea turtle in the waters of the Caribbean, off the coast of Cancun, Mexico.

Photo courtesy Naiara Altuna Renedo/
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scarce. Better data exist when they are larger juveniles and return to forage closer to coastlines.

“What young sea turtles do in between hatching and returned to nearshore waters takes place during what is called the “lost years” and is the foundation of sea turtle populations. Understanding where and when the youngest sea turtles go is critical to understanding the threats these young turtles may

encounter, and for better predicting population trends throughout the long lives of these species,” says Mansfield.

Moving to different localities

“While localised data collection and research projects are important for understanding species’ biology, health and ecology, the turtles studied in one location typically spend different parts of their lives in

▼ **Sargassum is a type of seaweed that can built up into huge mats in the open ocean, providing a retreat and feeding opportunities for young sea turtles.**

Photo courtesy
mlstudiodesign/www.
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other places, including migrating from offshore to inshore waters, from juvenile to adult foraging grounds, and between foraging and nesting areas,” adds Seney, who helped to co-ordinate data compilation from the multiple locations.

“Our extensive collaborations on this project allowed us to study the Gulf of Mexico’s three most abundant sea turtle species and to integrate nesting beach data for distant nesting populations that ended up having close connections to the 1- to 3-year-old turtles living and stranding along various portions of the U.S. Gulf coast. As an example, without the involvement of our Mexican and Costa Rican collaborators, a big piece of this picture would definitely have been missing.”



Further information

Nathan F. Putman, Erin E. Seney, Philippe Verley, Donna J. Shaver, Melania C. López-Castro, Melissa Cook, Vicente Guzmán, Beth Brost, Simona A. Ceriani, Raúl de Jesús González Díaz Mirón, Luis Jaime Peña, Miriam Tzeek, Roldán A. Valverde, Cristóbal Cáceres G. Cantón, Lyndsey Howell, Jonathan A. Ravell Ley, Mandy C. Tumlin, Wendy G. Teas, Charles W. Caillouet, Eduardo Cuevas, Benny J. Gallaway, Paul M. Richards, Katherine L. Mansfield.

Predicted distributions and abundances of the sea turtle ‘lost years’ in the western North Atlantic Ocean. *Ecography*, 2019; DOI: 10.1111/ecog.04929

Turtle tracking reveals key feeding grounds

Loggerhead turtles (*Caretta caretta*) feed in the same places year after year – and armed with this information, we need to protect these key locations, according to researchers in this field, so as to safeguard the turtles. University of Exeter scientists used satellite tracking and “stable isotope ratios” – a chemical signature also used by forensic scientists – to track female loggerheads from two rookeries (nesting beaches) in the Mediterranean. The study then identified three main feeding areas – the Adriatic region, the Tunisian Plateau and the eastern Mediterranean.

New insights

“We can show where the majority of nesting female turtles spend most of their life, meaning that in addition to their nesting beaches, we can also protect important marine habitats where they feed,” explains Julia Haywood, of the University of Exeter, based in the south-west of England. “Nearly half of the nesting population from Cyprus feeds on the Tunisian Plateau, an area known to have some of the highest turtle bycatches (accidental catches by humans fishing) in the world.” “Therefore, based on our studies, we support recommendations that this area should be conserved.”

The researchers tracked turtles from rookeries in Greece and Cyprus using data from 1993 up to 2018. “By studying these turtles for so long, we know that these females stay in the same feeding area over decades, which means if these habitats are damaged or have high fishing activity within them, then the turtles will unfortunately not move,” Haywood says.

“This then leaves them vulnerable to the disturbance in the area, which is likely to impact adversely on their numbers. The study shows the importance of combining satellite tracking and stable isotopes to



▲ A loggerhead turtle feeding on a conch shell. Ensuring that females are safe in their feeding grounds is essential to ensuring the reproductive success of the species. Photo courtesy Wet Lizard Photography/www.shutterstock.com



◀ A loggerhead turtle with a transmitter attached to its carapace.

Photo courtesy Thomas Barrat/www.shutterstock.com

help with understanding these elusive reptiles.”

A targeted response now possible

The work was carried out in collaboration with the local conservation groups: the Society for the Protection of Turtles in North Cyprus (SPOT) and ARCHELON, the Sea Turtle Protection Society of Greece. Robin Snape, of SPOT, adds “Mediterranean loggerheads lay their nests in the European Union, just at the time of year when hundreds of thousands of European tourists arrive on holiday.

“For the rest of the year, many female loggerheads are growing and foraging in the waters off Africa, where mortality in industrialised fisheries and even direct consumption of turtles are still big concerns. Each year at least 10,000 turtles

die as accidental bycatch off North Africa, while illegal trade in turtle meat also persists. This new research allows conservation resources to be prioritised to address specific threats in particular areas.”



▲ Conflicts between nesting loggerhead turtles and tourists can arise on European beaches, as the turtles come ashore to nest. Photo courtesy fotopanorama360/www.shutterstock.com



An adult loggerhead turtle spotted near the beach at Laganas on Zakynthos, which forms part of Greece's Ionian Islands,

Photo courtesy LauraVI/www.shutterstock.com

Further information

Julia C. Haywood, Wayne J. Fuller, Brendan J. Godley, Dimitris Margaritoulis, Jamie D. Shutler, Robin TE. Snape, Stephen Widdicombe, Judith A. Zbinden, Annette C. Broderick. **Spatial ecology of loggerhead turtles: Insights from stable isotope markers and satellite telemetry.** *Diversity and Distributions*, 2020; DOI: 10.1111/ddi.13023

New thalattosaur species discovered in south-east Alaska

Scientists at the University of Alaska Fairbanks have identified a new type of thalattosaur, a marine reptile that lived more than 200 million years ago, which was found in the south-east of the country. This new species, now named as *Gunakadeit joseeeae*, is the most complete thalattosaur fossil ever found in North America, and it has given palaeontologists new insights about the thalattosaurs' family tree.

Thalattosaurs were already alive during the mid- to late Triassic Period, when their distant relatives — the dinosaurs — were first emerging. They grew to lengths of up to 3-4m (10-13ft) and lived in equatorial oceans worldwide until they died out near the end of that period.

Reassessing relationships

"When you find a new species, one of the things you want to do is tell people where you think it fits in the family tree," admits Patrick Druckenmiller, director and earth sciences curator at the University of Alaska Museum of the North. "Here we decided to start from scratch on the family tree!"

According to Druckenmiller, prior to the discovery of *Gunakadeit joseeeae*, it had been two decades since scientists had thoroughly updated thalattosaur interrelationships. The actual process of re-examining a prehistoric animal's family tree involves collating dozens and dozens of detailed anatomical features from fossil specimens worldwide, then using computers to analyse the information to see how the different species could be related.

Druckenmiller acknowledges that he and his fellow collaborator Neil Kelley from Vanderbilt University were surprised when they identified where *Gunakadeit joseeeae* fitted. "It was so specialised and weird that we thought it might be out at the furthest branches of the tree," he explains. Instead, it's a relatively primitive type of thalattosaur that survived late into the existence of the group."

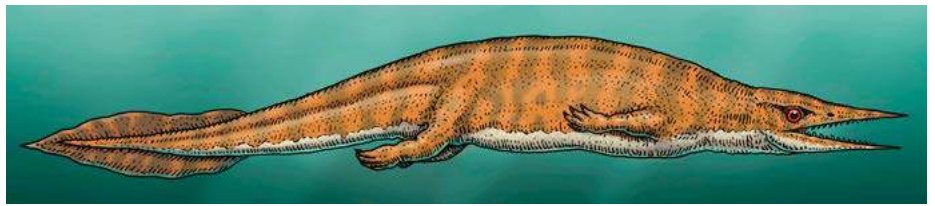
Back to the sea

"Thalattosaurs were among the first groups of land-dwelling reptiles to readapt to life in the ocean," explains his fellow collaborator Neil Kelley said. "They thrived for tens of millions of



▲ From left, Gene Primaky, Jim Baichtal and Patrick Druckenmiller stand in rising sea water after the last of the two blocks was removed. Minutes later, the tide submerged the excavation site.

Photo courtesy Kevin May, University of Alaska Museum of the North.



▲ A depiction of *Gunakadeit joseeeae*, which had a very distinctive appearance. Artwork © Ray Troll.



▲ The fossil of *Gunakadeit joseeeae*, which was found in south-east Alaska. About two-thirds of the tail had already eroded away when it was discovered. Photo courtesy of University of Alaska Museum of the North.

years, but their fossils are relatively rare so this new specimen helps to fill an important gap in the story of their evolution and eventual extinction."

That the fossil was found at all is remarkable, as it was located in rocks in the intertidal zone. The site in question is normally underwater for all but a few days a year. Yet in south-east Alaska, when extreme low tides hit, people head to the beaches to explore. That's exactly what Jim Baichtal, a geologist with the U.S. Forest Service's Tongass National Forest, was doing on the fateful day of May 18, 2011.

He and a few colleagues, including Gene Primaky, the office's information technology professional, headed out to the Keku Islands near the village of Kake to look for fossils. Primaky saw something odd on a rocky outcrop and called over Baichtal, saying "Hey Jim! What is this?". Baichtal immediately recognised it as a fossilised intact skeleton. He snapped a photo with his phone and sent it to Druckenmiller.

A narrow window of opportunity

A month later, the tides were forecasted to be almost that low again, over the course of two days. It was the last chance that they would have to remove the fossil during daylight hours for nearly a year, so they had to move fast. The team had just four hours each day to work, before the tide came in and submerged the fossil again.

"We rock-sawed like crazy and managed to pull it out, but only just in time," admits Druckenmiller. "The water was lapping at the edge of the site by the time we finished."

That was only the start of the process, however. Once the sample was back at the UA Museum of the North, a fossil preparation specialist worked in two-week stints over the course of several years to get the fossil cleaned up and ready for study.

Subsequent thoughts

When they saw the fossil's skull, they could tell

right away that it was something new because of its extremely pointed snout, which was likely an adaptation for the shallow marine environment where it lived. "It was probably poking around in cracks and crevices in coral reefs and feeding on soft-bodied critters," Druckenmiller suggests.

Its specialisation may have been what ultimately led to its extinction. "We think these animals were highly specialised to feed in the shallow water environments, but when the sea levels dropped and food sources changed, they had nowhere to go, and thus they died out," he says.

Once the fossil was identified as a new species, it needed a name. To honour the local culture and history, elders in Kake and representatives of Sealaska Corp. agreed the Tlingit name "*Gunakadeit*" would be appropriate. *Gunakadeit* is a sea monster of Tlingit legend that brings good fortune to those who see it. In addition, the second part of the new animal's name, *joseeeae*, recognises Primaky's mother, Joséé Michelle DeWaelheyns.



▲ The fossilised skull, seen in dose-up.

Photo courtesy of University of Alaska Museum of the North.

Further information

Patrick S. Druckenmiller, Neil P. Kelley, Eric T. Metz, James Baichtal. **An articulated Late Triassic (Norian) thalattosauroid from Alaska and ecomorphology and extinction of Thalattosauria.** *Scientific Reports*, 2020; 10 (1) DOI: 10.1038/s41598-020-57939-2

The future of fireflies

Habitat loss, pesticide use and, surprisingly, artificial light are the three most serious threats endangering fireflies across the globe, raising the spectre of extinction for certain species and related impacts on biodiversity and ecotourism, according to a Tufts University-led team of biologists associated with the International Union for the Conservation of Nature.

Fireflies belong to a widespread and economically important insect group, with more than 2,000 different species spread out across the globe. To better understand what threats are faced by fireflies, the team led by Sara Lewis, professor of biology at Tufts University, surveyed firefly experts around the world to size up the most prominent risks to the survival of their local species.

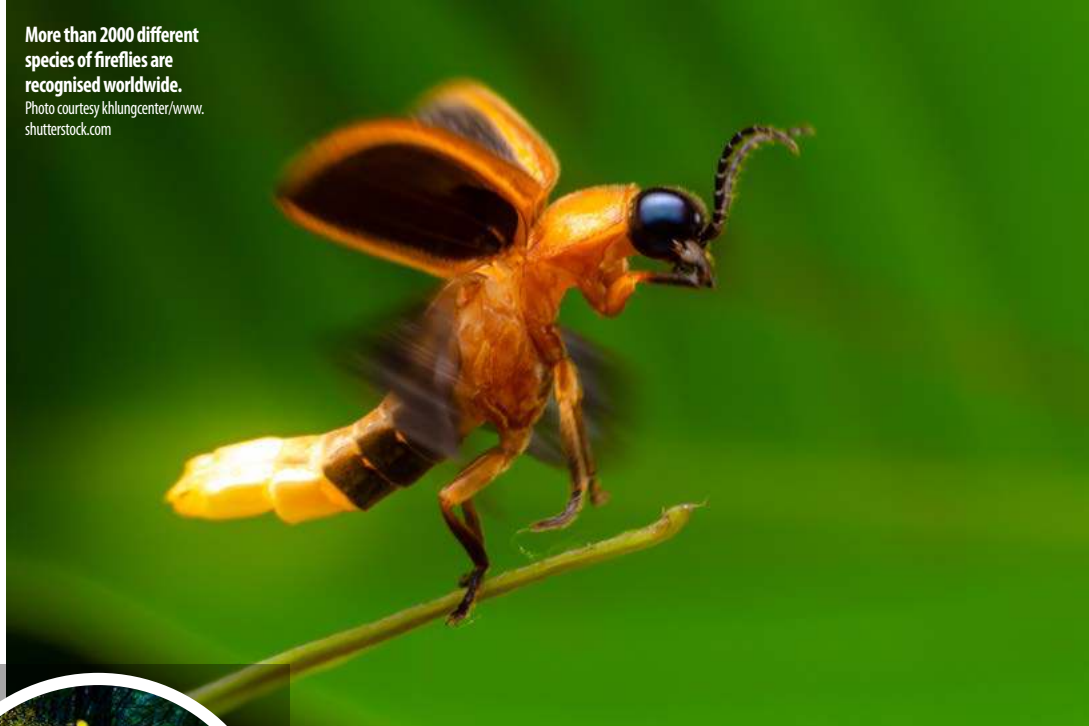
Declining numbers

This expert perspective and insights sound a warning bell about the insects' future, highlighting specific dangers and the vulnerability of different species across geographical regions. According to the survey's respondents, habitat loss is the most critical threat to firefly survival in most geographic regions, followed by light pollution and pesticide use.

"Lots of wildlife species are

More than 2000 different species of fireflies are recognised worldwide.

Photo courtesy khlungcenter/www.shutterstock.com



◀ An amazing display created by Japanese fireflies (*Luciola parvula*) in a forest.

Photo courtesy BlackRabbit3/www.shutterstock.com



declining because their habitat is shrinking," says Lewis "so it wasn't a huge surprise that habitat loss was considered the biggest threat. Some fireflies get hit especially hard when their habitat disappears, because they need

special conditions to complete their life cycle.

"For instance, one Malaysian firefly, known scientifically as *Pteroptyx tener*, which is famous for its synchronised flash displays, is a mangrove specialist. Previous research has revealed drastic declines in this species following conversion of their mangrove habitat to palm oil plantations and aquaculture farms."

An unexpected impact of a brighter world

One surprising result which emerged from the survey was that, globally, light pollution was regarded as the second most serious threat to fireflies. Artificial light at night has grown exponentially during the last century. "In addition to disrupting natural biorhythms - including our own - light pollution really messes up firefly mating rituals," explains Avalon Owens from Tufts University, who also worked on this project.

"Many fireflies rely on bioluminescence to find and attract their mates, and previous work has shown that too much artificial light can interfere with these courtship exchanges. Switching to energy

Pteroptyx tener is now under threat because of loss of its mangrove habitat.

Photo courtesy Preecha Ngamsrisan/www.shutterstock.com





efficient, overly bright LEDs is not helping," she adds. "Brighter isn't necessarily better."

Pesticides and their impact

Firefly experts viewed the widespread agricultural use of pesticides as another key threat to firefly survival. Most insecticide exposure occurs during larval stages, because juvenile fireflies spend up to two years living below ground or under water.

Insecticides such as organophosphates and neonicotinoids are designed to kill

pests, yet they also have off-target effects on beneficial insects. While more research is needed, the evidence shows that many commonly used insecticides are actually harmful to fireflies.

More information required

A few studies have quantified firefly population declines, such as those seen in the tourist-attracting synchronous fireflies of Malaysia, and the glowworm (*Lampyris noctiluca*) in England. And numerous anecdotal reports suggest that many other firefly species across a wide range of

▲ The most famous firefly display in the world - free from the impact of artificial light pollution - occurs in the Waitomo Glowworm Caves at Waikato on New Zealand's North Island.

Photo courtesy Shaun Jeffers/
www.shutterstock.com

habitats have also suffered recent declines. "However," Lewis points out, "we really need better long-term data about firefly population trends - this is a place where citizen science efforts like Massachusetts Audubon's Firefly Watch project can really help."

The researchers also highlight risk factors that allow them to predict which species will be most vulnerable when faced with threats like habitat loss or light pollution. For instance, females of the Appalachian blue ghost firefly (*Phausis reticulata*) are flightless. "So when their habitat disappears, they can't just pick up and move somewhere else," explains fellow investigator J. Michael Reed, Professor of Biology at Tufts.

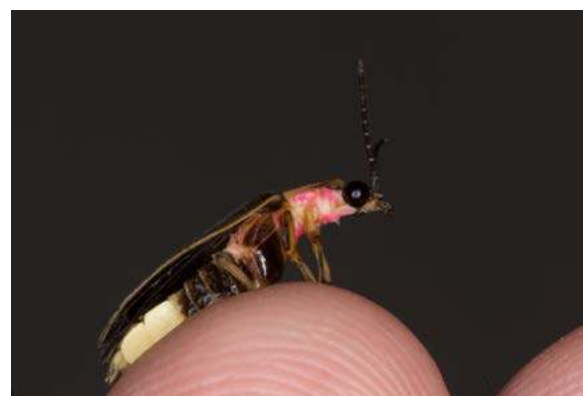
Lighting the path ahead

Yet overall, the researchers remain optimistic about the future of fireflies. "Here in the US, we're fortunate to have some robust species like the big dipper fireflies (*Photinus pyralis*)," adds Lewis. "Those guys can survive pretty much anywhere - and they're beautiful, too."

By illuminating these threats and evaluating the conservation status of firefly species around the world, researchers aim to preserve the magical lights of fireflies for future generations to enjoy. "Our goal is to make this knowledge available for land managers, policy makers, and firefly fans everywhere," explains co-author Sonny Wong of the Malaysian Nature Society. "We want to keep fireflies lighting up our nights for a long, long time."

▼ A big dipper firefly resting on a finger.

Photo courtesy Elliott Rusty Harold/www.shutterstock.com



◀ A common glowworm. This species is known to have declined, almost certainly for a variety of reasons including habitat loss.

Photo courtesy Gallinago...
media/www.shutterstock.com



Further information

Lewis, S.M., Wong, C.H., Owens, A.C.S., Fallon, C., Jepsen, S., Thancharoen, A., Wu, C., De Cock, R., Novák, M., López-Palafox, T., Khoo, V., and Reed, J.M. **A Global Perspective on Firefly Extinction Threats**, *Bioscience* (3 February 2020); DOI: 10.1093/biosci/biz157

Out of Africa

Lizard communication

Good communication is vital to maintaining structure within a group of lizards, such as these green iguanas.
Photo courtesy of the author.



Paul Donovan reflects on the interactions that occur between lizards, and how they communicate with each other and also ourselves.

If there's one thing I dislike more than anything else, it's shopping. Trudging around shops is something I could well do without, but unfortunately, it has to be done. The only consolation I get from this awful activity is watching a colony of rainbow skinks (*Trachylepis (Mabuya) margaritifera*) which have taken up residence in a planted rockery in the car park of one of the shopping malls I have to visit.

People must think I'm crazy because I'll spend 40 minutes or an hour just watching these skinks. The vast majority simply assume I'm just staring at a heap of rocks, and don't even realise there are lizards there! And if they do, their interest in them will never extend to observing the dynamics of their social behaviour. When I'm asked what I'm looking at, and I explain that I'm watching a group of skinks, the person concerned generally just wanders off

A male rainbow skink: a colony of these lizards frequent a rockery near Paul's local shopping mall.
Photo courtesy Christopher Reusch/
www.shutterstock.com





▲ A male fan-throated lizard (*Sitana ponticeriana*) displaying, revealing the vivid colouration of its dewlap. This agamid is mostly encountered in open areas, especially rocky ground, as well as in sparse forest across the Indian subcontinent. It is well-disguised by the brown colouration of its body, and its dewlap is only visible from the side once inflated.

afterwards, without a second glance in the direction of the rocks.

Interaction is complex

The way in which lizards interact with one another can be very complex. There are many opportunities for interactions, both within and between the sexes. Male lizards will react to protect their territory, their harem of females or simply when recognising another individual.

Females will also interact with each other, asserting their standing over lower ranking individuals, or challenging their existing position in the hierarchy. And if those individuals live in a social colony, communication is intrinsic to keeping order within that colony.

The actual process of communication is variable, and can occur in any of three ways, depending partly on the species, as well as the situation. Lizards can communicate visually, audibly and by means of scent, which is defined as chemical communication. Let's look at each of these in turn, in a bit more detail.

Visual communication

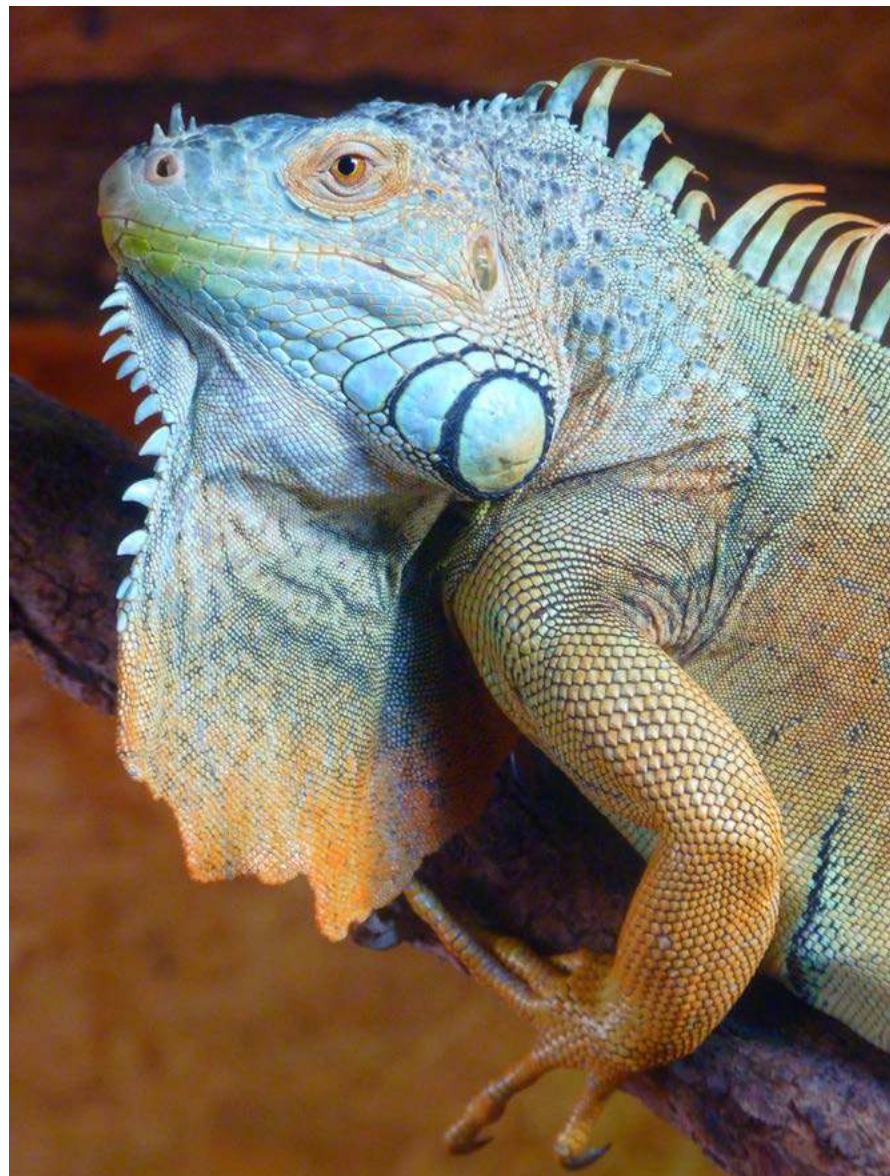
Communication is a behaviour in which one animal expresses its intention to another. Obviously, with humans, this is achieved primarily through vocalisation. But what is the process in lizards? There are various cues which lizards rely on for interacting with one another, be this male-male or male-female.

Some lizards can even go as far as

trying to communicate with us, if we know how to read the signs. You are likely to be familiar with this type of interaction if you have ever kept a green iguana (*Iguana iguana*). It is not uncommon for them to head-bob, or even to extend their dewlap when they see you.

In one collection where I worked, we had a large green iguana donated to us, who I christened Charlie. He was such a character, as most of his kind are. As soon as I turned the lights on and he saw me, he'd begin head-bobbing. And when I opened the door of his enclosure, he would leap out and sit on my shoulder.

Charlie did, at times, display the same head-bobbing movements to other members of staff with whom he was less familiar, but he would subsequently interact with them in an entirely different manner. He would tail-whip them, scratch, and even attempt to bite, and he could be particularly aggressive towards



► Green iguana have good eyesight, and can recognise their owners, often seeking to communicate directly with them, by their behaviour.

Photo courtesy the author.



women, aiming to assert his dominance.

The role of the dewlap

Head-bobbing and extending the dewlap in green iguanas serve as a means of visual social communication. Similar behaviour can be seen in other lizard species as well, notably anoles.

Communication of this type is highly complex, as well as often being species-specific, and three distinct forms have been recognised, as follows:

1. Simple: the dewlap is of a uniform colour and its inflation is accompanied by head-bobbing.

2. Compound: the base colour of the dewlap is broken by a big red spot in the middle, and this again is linked with head-bobbing.

3. Complex: the dewlap is intricately patterned with contrasting colours, accompanied by lines radiating out from the base to the edge. Head-bobbing may also be evident, but colour changes and head-bobbing can be carried out independently in this instance.

Given that the displays are complex, and are performed by all males, some degree of variation in

▲ A green iguana with an inflated dewlap. This behaviour is also usually accompanied by head-bobbing.
Photo courtesy Peter van Dam/www.shutterstock.com

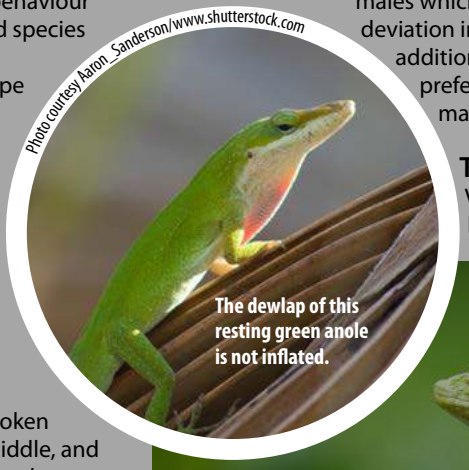
the display between the males must take place, certainly to allow females to determine between a strong displaying male and a weaker individual. Observations suggest that females seem to prefer "normal" head bobbing displays and will avoid males which exhibit any slight deviation in their bobbing action. In addition, bright colours are preferred by females over marginally drab ones.

serving many functions, which can be expressed in numerous ways. I have talked about head bobbing, and dewlap displays, but lizards will also express themselves by doing push-ups, raising their limbs, flattening the body against the ground, puffing up the gular region, and even raising the tail.

This last behaviour is particularly interesting, because it only occurs in a few species, and is therefore not as widespread as some of these other forms of display. It is very common, however, in the aptly-named zebra-tailed lizard (*Callisaurus*

Tail signalling

Visual communication is a highly complex behaviour



The dewlap of this resting green anole is not inflated.



In this case, the dewlap is fully revealed, revealing its distinctive colouration and patterning.



▲ Vocal communication is highly significant in amphibians, especially at spawning time.

Photo courtesy of the author.

draconoides). In this species, and those which display the behaviour, the underside of the tail is striped; however, the stripes do not extend all the way around the tail.

The fact that the lizards display these stripes to one another is a sure sign of social communication, and is widely seen in females lifting their tails in the presence of males, although male-male tail lifting is also common. The exact meaning of the display, however, is still not entirely clear.

Audible communication

In the amphibian world of course, auditory communication is widespread; frogs and toads can be extremely vocal, but in the case of reptiles, it is basically limited to just a few lizard species, although crocodilians can use this method of communication too. Auditory communication in lizards has surprisingly not been well-studied. In cases where it has, it can be linked



▲ Tokay geckos are amongst the most vocal of all lizards.

Photo courtesy chonticha stocker/www.shutterstock.com

▼ Tail-lifting is a phenomenon used for communication in the zebra-tailed lizard, but is not widespread in the world of lizards.

Photo courtesy Charles T. Peden/www.shutterstock.com

with male-male territorial reinforcement, courtship, and even defence.

If you have ever kept a tokay gecko (*Gekko gecko*), and tried to pick it up, you may very well have dropped it the first time you did so, being surprised by its 'bark' when being handled. This is a defensive mechanism intended to shock a would-be predator and result in this reaction, thereby allowing the gecko to make its escape.

Barking in this fashion is also useful

to communicate with other individuals in the area. Indeed, these geckos can prove to be extremely vocal at night, when they are primarily active - with their lifestyle being indicated by the slit-shaped rather than rounded pupils in their eyes. These vocalisations provide a straightforward means for them to keep in touch, when it will not be as easy to spot the presence of near neighbours as in the daylight.

By and large, auditory communication is carried out on a



one-to-one basis, but in some species, such as the common barking gecko (*Ptenopus garrulus*) which occurs here in Africa, the males sit at the entrance to their individual burrows and call in unison during the evening, emitting an ear-piercing, clicking sound.

The calls of these geckos can often be confused with reed frogs calling. While I have camped in areas populated by reed frogs and easily drift into sleep under their warbling choruses however, the same cannot be said for the nightly renditions given by *Ptenopus*; I need to wear earplugs to get to sleep easily in such surroundings!

The case of the tuatara

One reptile which uses both visual and auditory communication, is the tuatara (*Sphenodon punctatus*), whose distribution is restricted New Zealand. Although it has a very lizard-like appearance and is closely related to them, the tuatara is actually the sole survivor of an more ancient group of reptiles known as rhynchocephalians. They used to have a much wider distribution across the world.

Territorial disputes in this case are determined by a tuatara threatening a rival, by 'puffing' itself up to appear larger than is actually the case. Further intimidatory signs include raising the dorsal spines, and increasing the darkness of the skin.



▲ The tuatara has a decidedly lizard-like appearance.

Photo courtesy Shirley Evans.

▼ Chemical communication is important in the case of skinks.

Photo courtesy kaman985shu/www.shutterstock.com

A male common barking gecko at the entrance to its burrow.
Photo courtesy Chris Erasmus/
www.shutterstock.com



These are behaviours that are often seen in lizards as well of course, emphasising the relationship between these two groups.

The owner of the territory will then respond to the challenge by shaking its head determinedly. Although this response is usually enough to see off the intruder, if the challenger is determined, the tuataras will approach one another head on, and begin snapping their mouths open and shut. The standoff then sees them chasing one another while croaking at the same time. The dominant individual will proceed to bite and tail-whip the intruder. This is usually enough to encourage it to retreat and seek sanctuary elsewhere.

Chemical communication

We can see visual interactions between lizards, and hear the sounds that they produce, but the third category of communication that we cannot recognise easily is the output of odours. Amongst the groups that engage in chemical communication are the Scincidae and Lacertidae. Chemical cues are the most sophisticated of all forms of communication. Although generally used by the female to attract a mate during the breeding season, these also provide a means for individuals to recognise one another and their presence in an area.

There is some evidence to suggest that females of skinks living communally can identify members of their particular colony, and distinguish these individuals from other members of their species, by their odour. In addition, females of certain species can identify their offspring from those of other females. However, once the two are separated, the ability of the mother to recognise her offspring is lost.

It is currently unclear as to how the mother can identify her young, but there is some evidence pointing to the presence of pheromones in the skin, from the femoral pores, and even odour present in their faecal matter. Indeed, this has been shown to play an important role allowing juvenile green iguanas to recognise their siblings.

The presence of chemical odours therefore play a fundamental part in allowing a social group of lizards to maintain their colony and its structure, permitting them to recognise one another, and the place of the individuals within it. In those species where adults may cannibalise their young, or are aggressive





towards them, chemicals within their faecal matter allow the young to detect adults, and so avoid a potentially harmful situation.

The use of chemical communication is also important when it comes to mating. A female will give off chemical signals to indicate that she is ready mate, and can also determine the health of a male by the pheromones he releases, deciding whether to accept or rebuff his advances.

No matter how impressive some sexual displays are by the male, if he is not giving out the correct chemical cues to attest to his strength, he will have little chance of mating. This is why the strongest males maintain a

harem, and weak nomadic males attempt to take their chance with a female when the dominant male is distracted elsewhere.

Femoral pores

Many lizards possess structures on the ventral surface of the thigh called femoral pores which exude a waxy secretion, and these are usually larger in males, providing a means of distinguishing between the sexes in day geckos (*Phelsuma species*) for example. These pores, and their waxy secretions have also been found to play an important role in communication.

Not only do they contain secretions which align to mating but they are

▲ The interactions within a group of lizards are complex, and changeable. A lizard that loses its tail, as seen here in the front of this group, will slip down the social ranking, even if it was previously a dominant male. Photo courtesy of Efes Kitap.

▼ The femoral pores can be clearly seen here, running down the inside edge of the upper part of the legs. Photo courtesy the author.

also potentially important in terms of scent-marking territories. Males with higher levels of a chemical called hexadecanol in the waxy secretions can signal their dominance to other males, as well as their state of health, by the trail of hexadecanol that they leave behind as they move around.

Tail-end

The social life of lizards can be complex, and communication is vital. A male often needs to establish a territory which he then has to protect from other males. Within this territory, he may live with a group of females, which again, must be guarded from rival males. And within this group of females is a basic hierarchy. The male will also know when a female is sexually receptive, and can distinguish his own offspring too, in some cases.

All of these behaviours are based on various visual, occasionally auditory and also chemical means of communication. And who said reptiles were simply uninteresting? I am certain there is much more to discover in this area as well! ❖

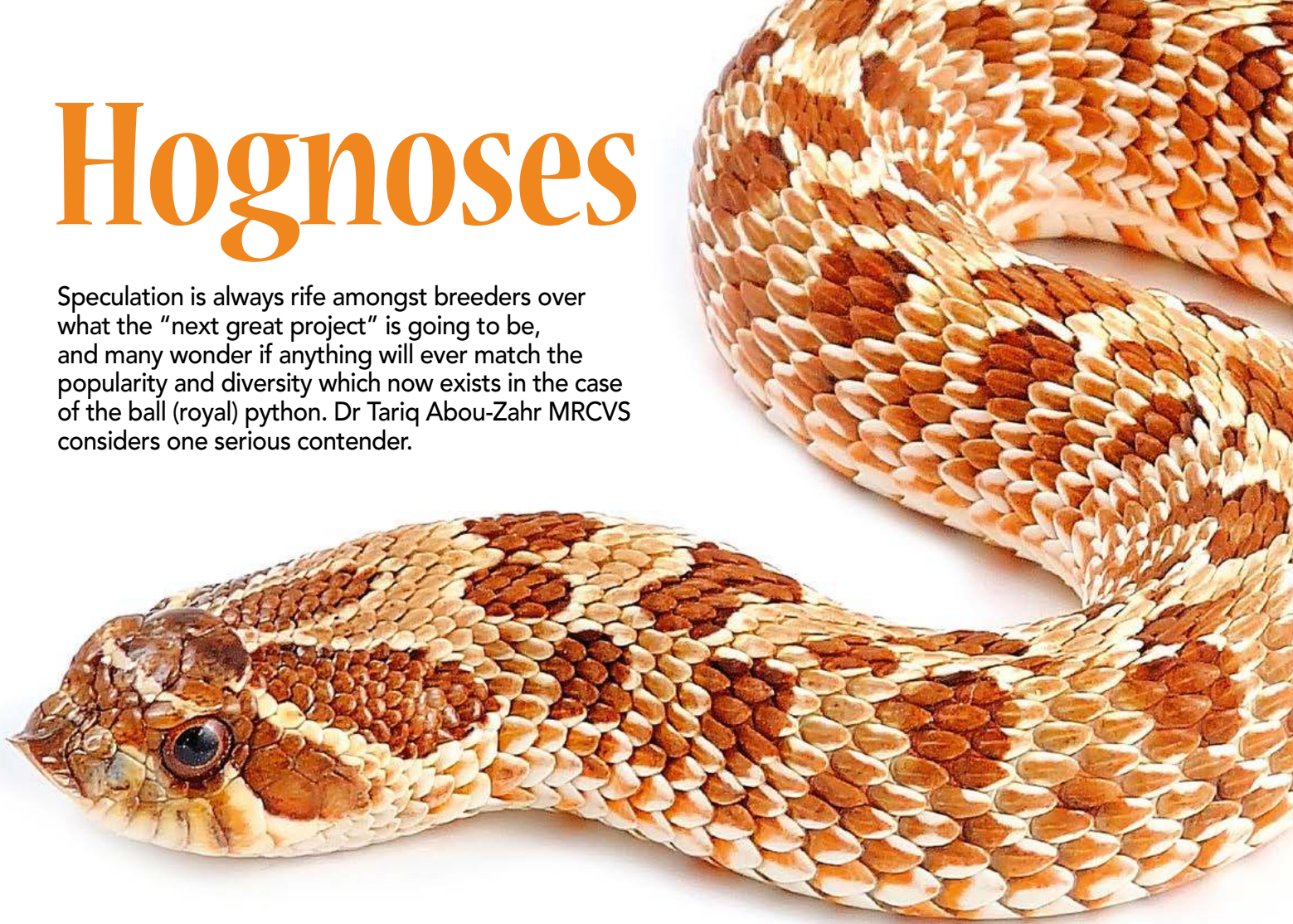


Want to see more of Paul's adventures?

Don't forget to check out his YouTube channel: www.youtube.com/bushadventuresafrica

Hognoses

Speculation is always rife amongst breeders over what the "next great project" is going to be, and many wonder if anything will ever match the popularity and diversity which now exists in the case of the ball (royal) python. Dr Tariq Abou-Zahr MRCVS considers one serious contender.



Hognoses, and particularly the western hognose (*Heterodon nasicus*), represent one of those genera that seems to be growing very rapidly in popularity at present. In fact, many people who keep ball (royal) pythons are starting to set up hognose projects on the side. I have talked with three hognose specialists to investigate some of the methods used with success in keeping and breeding these colubrids.

The following contributions are from Justin Mitcham of Extreme Hogs in Texas; Stefan Griep and Raimo Hühn of Reptiles Breeding Enterprise in Germany, and Ian Chiles of hognosemorphs.co.uk, based in London. I asked all three to give readers an overview of how they set up their snakes, and how they approach successful breeding. Justin Mitcham opens the discussion from across the Atlantic.

The American view

In Justin's opinion, the western hognose is among the most charming and beautiful of the North American colubrids. Their small but robust size, amazing personalities, colours and patterns ... in his view, it is easy to understand why they're a favourite with hobbyists and breeders alike. An expanding multitude of new morphs means that the breeding possibilities are becoming almost infinite.

Care for this species is quite overall simple, but is a little more advanced than for a typical colubrid species. For many years, western hognoses were treated in a similar way to corns, kings and other temperate climate species. But this approach is not ideal, firstly because they benefit from warmer surroundings and also from more frequent feeding. Justin's method of keeping these snakes is as follows, being based on

their natural environment which extends from southern parts of Alberta and Manitoba in Canada through the USA into northern parts of Mexico.

In most of their range, the summer temperatures reach in excess of 32°C (90°F). Humidity is quite low, usually being 50% or lower. So to mimic this, he provides a 28-32 quart drawer that has a basking spot of 31-32°C (87-90°F), using heat tape. Ambient temperatures are kept between 27-30°C (80-86°F) with a 12-16 hour daily light cycle. Basically no special lighting is needed: and leaving the room light on will be enough. He makes sure that the enclosures have plenty of ventilation by incorporating two or three oscillating fans in the room, and this also helps to eliminate any temperature variation.

Western hogs need to feed at least twice a week, thanks to their relatively high

This row of pictures © Justin Mitcham.



▲ Axanthic hognose.



▲ Leopard hognose.



▲ Pastel pink hognose.

Scents that can be used

- Salmon scent works very well!
- Tuna scent
- Broth from Vienna sausage can
- Chicken broth
- Frog scent
- Toad scent
- Chicken scent
- Anole scent
- Gecko scent
- Boiled egg
- Brained pinkies

metabolic rate. Subadults and adults are generally fed 1-2 small adult thawed mice twice per week. In the wild, they eat small meals consisting of many types of prey, ranging from rodents and lizards to amphibians and even insects. Justin uses mice as the main dietary ingredient for his snakes. Since babies shed almost immediately after birth, they can be offered food usually within 3-6 days of hatching. He starts them off by using frozen and thawed pinkie mice heads and usually within about 2-4 weeks, the majority will be feeding on these without scenting. The percentage of babies that do not feed on unscented thawed will need to be started on scented food items.

Justin's breeding routine

Now before you have babies of course, you need to learn how to breed the adults. Some breeders do not brumate their hogs. Justin believes this goes against the animal's basic nature and does not produce the best results. Brumation for hogs is fundamentally the same as for most North American colubrids. They do well with eight weeks between the temps of 7-18°C (45-65°F) in 50% or lower humidity. Make sure to use a dark, quiet, dry place, keep the humidity low and give them plenty of bedding to burrow in with access to water.

After you resume feeding, keep track of their shed cycles, feeding and weights. It is best to write this information down. Keep in mind that females need to be about 250-300g (9-11oz) or more and males at least 50g (2oz) in order to breed. Justin has bred many hognoses very successfully at one year of age. It seems weight is the primary factor that determines sexual maturity, not age.

After brumation (generally 3-8 weeks

later), the female will go through a pre-ovulatory shed. She will then swell almost as if she has eaten a large meal. Introduce the male at the same time every three days. If using multiple females per male, you may want to limit copulations to 2-3 per female, so as to increase the overall chances that all the females you breed will become gravid.

Egg-laying to hatching

About four weeks after breeding, the female will need a nest box to lay her eggs in. She will become very restless and will constantly look for a place to lay until the final few days prior to egg laying. A plastic container with a medium sized hole cut in the lid works well, make sure to fill it with 2/3rds damp sphagnum moss or potting soil. The female will shed again about 3-14 days before egg laying.

After she lays, remove the eggs promptly and place them in a small container filled with large grain vermiculite (particles of which are about half the size of a pea). Place a deli cup filled with water in the middle of the container and place your eggs in the medium. Put the lid on and incubate at 27-29°C (80-84°F) for 45-65 days. Remove the lid every 5-7 days for air exchange or make 3-5 very small holes about 0.5mm (0.02in) in diameter here.

Hognose snakes live mostly in arid to semi-arid environments and their eggs are prone to over-absorption of water which will kill the embryos. This method allows for the perfect exchange of moisture and increases hatch rate. If you not comfortable with this method, a water to weight ratio of 1 to 5 works well with perlite or vermiculite mediums.



▲ Egg-laying hognose.



▲ Hognose eggs being incubated.

This is Justin's routine

Dec 15: Start cooling down with temperature fluctuating from 21-24°C (70-75°F), stop feeding and reduce lighting to a few hours a day.

Jan 1: Brumation begins at 10-16°C (50-60°F). No light.

March 1: End brumation, raising the temperature up to 27°C (80°F) over 3-5 days, increase lighting.

March 3-5: Resume feeding.

April-June: Breeding.

June-July: Egg laying.

July-Sept: Hatching.



▲ Toffee hognose.



▲ A hognose nestbox.



German input

For a more European perspective, Stefan Griep and Raimo Hühn of Reptiles Breeding Enterprise in Germany have also given Practical Reptile Keeping the benefit of their experience in keeping and breeding hognoses. This is what they had to say:

Since colour morphs in western hognose snakes are increasing significantly in numbers at present and they are growing rapidly in popularity, we are very pleased to be able to contribute our experiences about keeping and breeding them. Hognoses live in a wide range of different habitats in the wild and can therefore typically adapt very well to different conditions. As a result, there is no set care sheet and as long as they do well, then you are keeping them correctly. The following is a summary of our approach to the husbandry of these snakes.

They definitely prosper best when being kept individually and as far as we are concerned, this is the safest way to maintain them because they are known to feed on reptiles and amphibians in the wild. Cannibalism is in theory possible. One thing that is absolutely essential is to choose an appropriate enclosure size. This is especially true for the hatchlings and younger snakes because they will stop feeding if they feel insecure. We keep them all in rack systems with tubs of

Hognoses live in a wide range of different habitats in the wild and can therefore typically adapt very well to different conditions.

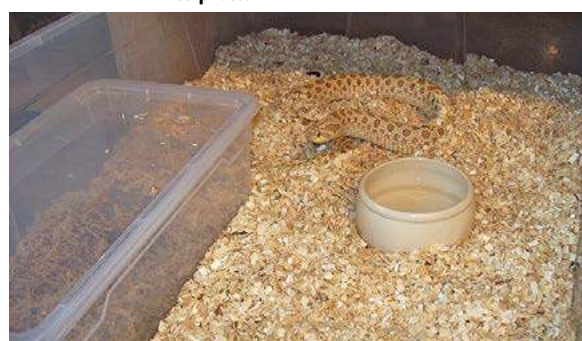
various sizes.

From hatchling size to about 15-20g (0.5-0.7g) we use 17x12x5cm (7x5x2in) boxes. For the sub adults and for most adult males (because these stay rather small) 39x28x14cm (15x11x6in) boxes are utilised and for the females (which incidentally can grow to be 90cm/36in), we use 80x55x18cm (32x22x7in) boxes. We prefer a very basic setup on the whole, simply consisting of a substrate of aspen bedding, about 3-5cm (1-2in) deep, and a water bowl. We make two exceptions. Hatchlings will get paper towel as a substrate and the big females get a wet box filled with sphagnum moss. During the day, we heat the whole room up to about 28-30°C (82-86°F) and at night, this drops down to 26°C (79°F).

The best size for breeding is 250-300g (9-11 oz) in females and 50-60g (2-2.5oz) in males. For a successful breeding, these snakes need a winter rest period of about 8 to 12 weeks. Before any temperatures are



▲ Racking system in use at Reptiles Breeding Enterprises.



▲ A big tub at Reptiles Breeding Enterprises.



▲ A fluor-albino hognose kept by Reptile Breeding Enterprises.



© Stefan Griep.

▲ Pink pastel albino hog-nose.

lowered, snakes should be fasted for about 3 weeks. Failure to take this step can prove lethal as temperatures prove too low for digestion of consumed meals, and food rots within the reptile's digestive system. We cool our snakes down to 15-18°C (59-64°F). Some other keepers go as low as 7-10°C (45-50°F).

After slowly raising the temperature and having fed the animals very well, the breeding pair should be introduced and allowed to spend 24 hours together. This coupling is repeated every 4-6 days. Egg development can take from 3 to 8 weeks, and is associated with an extensive increase in size in the last 40% of the female's body. About 5-14 days after the 'pre lay shed', eggs can be expected. The clutch size can vary from four up to 25 eggs, but large clutches of around 30 eggs are also known.

Hatching and rearing

We incubate the eggs of our hog-noses in a medium of three parts perlite and



© Stefan Griep.

▲ Toffee belly hog-nose, lightening phase.

vermiculite mix, with one part water. Our preferred incubation temperature is 27.5°C (82°F), and after a waiting time of 50-55 days, we can begin to enjoy watching the new little beauties hatch. It is important to note that it can take up to five days between the first egg piping and the last egg hatching.

Shortly after hatching, the neonates shed for the first time. This typically happens during their first day of life. We offer an initial feed 4-7 days after hatching, so that they have had time to absorb and consume the reserves from the yolk sac, and we find that about 90% of them take defrosted pinkies at this time without issue. We offer the first meal in an opaque tub (about the size of a cricket box) with a transparent lid, and the snakes have between early afternoon and the following morning to eat it.

About 10% of new hatchlings fail to eat straight away, and need a little bit more encouragement. These snakes can be a real pain, and we often find



▲ Anaconda hog-nose - so-called because of its patterning. © Stefan Griep.

that waiting for them to take their first meal is the most nerve-wracking process we encounter in this hobby! With perseverance however, almost all feeding issues are overcome. Generally, if the snakes fail to eat after four standard attempts, we give them a break for four days and then try some "tricks".

In the case of almost all problematic feeders, we find that if you take the water bowl out for a few days and moisten the pinkie with some fresh water – they eat. If this fails, we try scenting the pinkie with either some chicken meat, or the water from a tin of tuna. Fortunately, it hardly ever goes this far, and the snakes usually give up and take a meal before we need to resort to alternative scenting.



▲ Toffee belly, regular. © Stefan Griep.



A British perspective

Finally, we have some information from here in the UK from Ian Chiles, a respected breeder of hognoses, and an example of a hognose breeder who is also working with ball pythons.

I have been keeping reptiles since the early 1980s and have successfully bred mangrove snakes, royal pythons, various Asian rat snakes and hognoses. I now focus my attention on breeding purely hogs and royals, as these have become my favourites after many years. My collection consists of albinos, extreme red albinos, anacondas, Mexicans and a variety of female westerns.

Hogs are rear-fanged venomous snakes, and while they are generally all full of bluff, they can bite! All of my bites to date have occurred during feeding and I would strongly recommend feeding with tongs at all times, to avoid any accidents. My worst bite came from a small male albino, and caused my finger to nearly double in size over a 24 hour period, but this was the only reaction I had.

A lot of my methods have been picked up from various US breeders, most notably

Justin Mitcham of Extremehogs.com, who has also contributed to this article. All my animals are kept in tubs of varying sizes. Adults are housed in 32 litre tubs and hatchlings in 0.9L boxes, with 5L & 9L tubs once they have outgrown their smaller homes. Heating is provided by thermostatically controlled mats, with a hotspot of 31-32°C (88-90°F) and a room temperature rarely going below 24°C (75°F).

My adults are kept on a substrate of aspen bedding which I find works very well, allowing them to burrow and root around. It is also highly absorbent and easily soaks up any mess. Hatchlings are kept on paper towel and furnished with a small tight-fitting hide box and small water bowl. I feed all of my hogs approximately once every 4-5 days, mainly small to medium food items, whether hatchling or adult. I find they do very well on this regime and within two days of being fed are on the lookout for more. This way they stay lean and mean!

Conditioning and breeding

I brumate all of my adult hogs starting in

mid-December. Around 1st December, I stop all feeding and give them two weeks to empty their stomachs. I then turn off the heat mats and a few days later bring them into one of my cooler rooms. Soon after, I place them under my kitchen sink on shelves and have found this gives me a fairly constant 10°C (50°F) throughout the winter months. I check them twice weekly and change their water. Towards the end of January, I bring them back into the snake room and put them back into their tubs, waiting 24 hours before turning the heat mats back on. I leave them for seven days to get acclimatised and then offer them a small mouse. A week later, I continue feeding as normal.

After they have a good few meals inside them I start to introduce the males to the females, leaving them together for 24 hours at a time. I may witness copulation or see nothing at all: at this time, it is important not to disturb them too much. As females are much larger than males, you do not want the female to drag the male around when they are locked up!

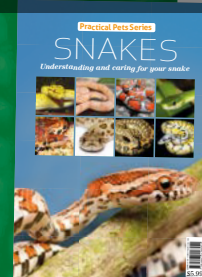
I tend to leave a laying box filled with



▲ Albino hognose hatchlings coming out of the egg.

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vermiculite with the females soon after a round of breeding. This can be as simple as a plastic box with a small hole in the lid, big enough to comfortably accommodate the female. The females lay between 5-14 days after their pre-lay shed; by this time the eggs are easily felt by letting them crawl through your hand.

Once laid, I place the eggs in a small plastic box with very slightly damp vermiculite: when you grab a handful and squeeze it should all fall apart. I try to keep the

substrate very dry. I incubate the eggs at a temperature of 27-28°C (80-82°F), and incubation generally takes 55-60 days. I have had 100% hatch rate these last few years and do think the drier substrate has helped.

Baby hognoses tend to shed in the egg or very soon after hatching and I offer them a small pinkie mouse around 7-10 days later. Some feed without any problems but others can be incredibly stubborn and may take many months to get feeding normally. I have found scenting to be a great aid to feeding

and have had most success with tinned red salmon, lance fish and cream of chicken soup amongst others. Once established, I feed them every four days, again offering small food items.

I believe the hognose has a very bright future in the hobby as there are now dozens of stunning morphs available and we have not even started to explore all of the different combinations. Their small size and ease of care makes this a great snake for the beginner or advanced keeper! ❖



▲ The young ghost hognose with hypo and axanthic morphs © VIN RUSSO.



Pink panther.



Dorsal striped anaconda.

MORPH PHOTOS BRENT BUMGARDNER/SUPERCONDA.COM.

Hognose behaviour

The distinctive snout of these snakes helps them dig up buried toads, which form a major part of their diet in some areas in the wild. They are not especially aggressive snakes, but they can put on a very intimidatory display if threatened, acting rather like a mini-cobra, rearing up, flattening their heads and hissing at a would-be aggressor. If this does not work though, they have another defensive technique that can be employed. The hognose simply rolls over on to its back, and remains immobile, seemingly dead. As if to reinforce this impression, the snake can produce some drops of blood from its mouth, with its tongue lolling out motionless. Such behaviour can sometimes occur with hognoses that are not used to being handled, and it can be very alarming. Left alone though, the snake soon recovers. Even though it feigns being dead, it is still alert to what is going on around it, recognising when the danger has passed.

Introducing tortoises

The origins of today's tortoises can be traced back as far as the late Triassic period, around 200 million years ago. At that stage, all members of the group were turtles though, living in aquatic environments, and it was to be another 150 million years before some members of the Emydidae family of turtles took their first tentative steps to colonise land.

This event may have occurred first in either Africa or North America. These proto-tortoises were probably similar in size to today's Burmese tortoise (*Manouria emys*), and characterised by their relatively flat shells. They would almost certainly have lived in marshy forests, and interestingly, their diet soon changed, away from the predatory nature of their aquatic relatives.

These early tortoises presumably developed a taste for fruit and vegetation, although they may also have preyed on slow-moving invertebrates such as molluscs. While in water, their turtle ancestors possessed the necessary speed and agility to catch fish and other creatures without difficulty, but it was a very different situation on land. Here, their lack of speed meant that not only were tortoises unable to pursue prey, but they themselves were also more vulnerable to predators.

Locomotion too needed more effort, and over time, the body profile of tortoises altered, with their shells becoming more domed. This meant that their lung capacity could increase, assisting their greater requirement for oxygen on land. In addition, would-be predators now faced greater difficulty in terms of attacking these reptiles, as the increased height of the tortoise's shell would no longer fit so easily into the jaws.

The spread of tortoises

Over time, and possibly as the result of climatic shifts, tortoises started to expand



their range out beyond the forests that they initially colonized. They moved into grassland areas, and pushed into colder regions too. Their gait became more refined, and some started to walk simply on the tips of their toes, although interestingly, the basic structure of their pelvis has not altered significantly from that of their aquatic relatives.

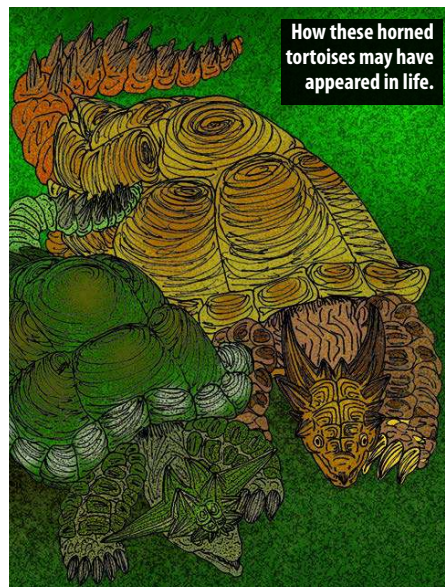
It is impossible to be certain of how many different species of tortoise have existed, but it is clear that they used to occur over a much wider area in the past than is the case today. Estimates suggest there may have been over 200 species in total, of which there are some 38 still alive today.

Their family, Testudinidae, has representatives on all continents today, aside from Australia. It was here, however, that one of the most bizarre and distinctive groups, known as the meiolaniids or horned



▲ A horned tortoise (*Meiolania platyceps*), revealing the distinctive horn-like projections on its skull. This fossil specimen is in the Lord Howe Island museum.

Photo courtesy David Morgan-Mar.



How these horned tortoises may have appeared in life.

tortoises, existed until quite recently - up to about 120,000 years ago.

This group appears to have evolved in the region of what is now South America, just as the era of the dinosaurs was drawing to a close some 65 million years ago.

Representatives of this family occurred on mainland Australia and offshore islands such as New Caledonia, but it was on Lord Howe Island, off Australia's east coast, where they finally became extinct. Climatic change and rising sea levels, which left just the steepest slopes accessible, were probably the most significant factors in their ultimate demise.

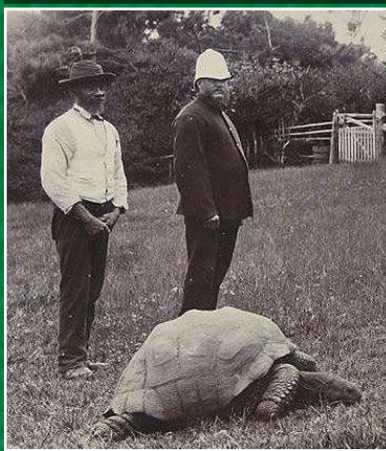
The distinctive horns of these tortoises grew almost horizontally from the side of their head, and gave the skull a total width of at least 0.6m (2ft). Their tail was also protected with bony armour, although as to why this protection was needed is unclear.



A North American gopher tortoise (*Gopherus polyphemus*) with bite marks visible in its shell.

Did you know?

Tortoises have a justified reputation as ranking amongst the longest-lived vertebrates on the planet. The oldest known tortoise alive today hatched around 1832. Jonathan, as he is known, was taken to the island of St Helena in 1882, and has been resident there ever since. He is now approaching the age of Tui Malila, regarded as the oldest known tortoise on record, who died in 1965 on Tonga at 189 years old.



Jonathan, photographed on St. Helena around 1900. Source: PD.

Giants past and present

The size of these meiolaniid tortoises is such that members of this group include the second largest tortoise species known to have existed. They could grow to a total length of up to 2.5m (8.5ft) and so would have dwarfed the so-called 'giant' species of today.

The biggest tortoise ever recorded, however, was *Colossochelys atlas*, whose range extended over a wide area, from present-day India and Pakistan in the west through to the Indonesian islands of Timor and Sulawesi. The total length of these



Fibreglass life size model of *Colossochelys atlas*, the largest-known tortoise. Photo courtesy Vjdchauhan, CC BY-SA 3.0.



▲ An Aldabran giant tortoise.

giants was approximately 2.7m (9ft) overall, with a shell that measured 2.1m (7ft). *Colossochelys* would have stood about 1.8m (6ft) tall, with its neck fully extended, meaning that it could easily have browsed on bushes without difficulty.

By way of comparison, Galápagos giant tortoises (*Chelonoidis nigra*), which are the largest species alive today, grow to no more than 1.8m (6ft) overall, and their weight is unlikely to exceed 200kg (440lb). These tortoises are now found on seven of these volcanic islands, which erupted from the sea.

How they reached there is a mystery, but it is believed that their ancestors probably drifted to the islands from Central America, possibly on rafts of vegetation, with their size and shape then changing over time, as they adapted to the landscape of their island homes.

Since female tortoises can lay fertile eggs for several years after a single mating, so this increases the likelihood that they could have colonized islands in this way.

A second, separate population of giant tortoises (*Aldabrachelys gigantea*) occurs on

the Aldabras and neighbouring islands in the Indian Ocean. It is believed they may be descended from tortoises carried from the African mainland in a similar fashion, drifting on the ocean currents.

Mediterranean tortoises

The ancestors of today's Mediterranean tortoises, which form the genus *Testudo*, were in existence by the Eocene, around 40-50 million years ago, with their earliest remains having being unearthed in France.

Those which are now popular as pets - the Mediterranean spur-thighed (*T. graeca*) and Hermann's tortoise (*T. hermanni*), can be traced back through the fossil record for nearly two million years, and the ancestral species used to have a much more extensive distribution along the northern coast of the Mediterranean, compared with the situation today.

Members of this group also ranged much further northwards as well, with the remains of one species, called *Testudo comptoni*, having been unearthed in Eocene deposits on the Isle of Sheppey, near London. ♣

Tortoise terminology

Tortoises and turtles form the order Chelonia, and so the description of 'chelonian' is a general term often applied to members of this group. It is usually accepted that tortoises are completely terrestrial in their habits, whereas turtles tend to be more aquatic by nature, with marine species in particular tending to be wholly aquatic. Females only come ashore to lay their eggs in the latter case. On the other hand, the American box turtles (*Terrapene* species) are largely terrestrial.

There are some specific terms used to describe a tortoise's shell, which is in effect a double-layered structure. There is an inner bony casing, comprised of about 50 bones that correspond to the shape of the shell, above which are the pigmented areas comprised of keratin - the same material as makes up our nails. These give the tortoise a unique appearance, with the markings themselves tending to be as distinctive as fingerprints, in the case of species with patterned shells.

The upper part of the shell is known as the carapace, with the lower area beneath the body being referred to as the plastron. The individual segments, or scutes, on the shell have a series of names, relating to their position. Those around the edge of the shell are described as the marginal scutes for example, whereas those across the back are vertebrals and the one immediately behind the neck is the nuchal.

Reptiles and amphibians are now known to be very responsive to training. Techniques of this type are being used to help veterinary examinations in zoos for a range of species today, ranging from crocodilians to frogs. They can also help you to build a closer bond with your pets, as Dr Julia Mueller-Paul explains.



Training your reptile

Not all that long ago, the general opinion was that reptiles and amphibians had very poor learning abilities. Many people believed they were mere automatons, behaving on instinct alone and being quite incapable of learning anything new. Today of course, we know that this is very far from the truth. Personal experiences as well as scientific research have shown that both reptiles and amphibians are able to learn and master sometimes even complex tasks, when provided with the right conditions. But what are the right conditions and how can we use them to teach our own pets? To answer this question, it is first necessary to understand a little about how animals learn.

Learning mechanisms

Habituation is a very basic learning mechanism, and refers to the animal simply getting used to a certain circumstance. For example, a lizard that at first may have been frightened by the noise of its terrarium's sliding doors often loses its fear by repeated exposure, realising that this poses no serious threat to its well-being.

This effect can be reversed though, if

the exposure to the noise stops. So, if the lizard is kept in an enclosure with a different kind of door for some time, and is then returned to its original vivarium, it is likely to be disturbed again by the noise of the original door for a period of time. For the owner, this means that their reptile's environment should, if possible, not be varied too often so as to avoid dishabituation and a repetition of any frightening situations.

A slightly more complex learning

mechanism is called classical conditioning. Here the animal connects a neutral stimulus like a specific sound with a positive outcome that causes a change in its behaviour. For example, if you rang a bell every time just before feeding your group of tortoises, they might eventually gather in their feeding area as soon as they hear the bell, irrespective of whether there is food present at the time or not. This is because the tortoises associate the ring of the bell with their snack time,

➤ **Handling crocodiles has been made much easier and safer with reward-based training.**





Dart frogs can learn and respond to their owners.

faster while others need more time, and both animal and owner must get used to the requirements of the lessons too.

Rewarding in the right way

The most essential part of animal training is to reward correctly. Associations between rewards and actions only develop when the reward is given immediately after the action. The closer the timespan between the desired action and the animal receiving its reward, so the greater the chance that the animal will learn this particular action leads to a positive outcome, and is worth repeating.

Ideally, you will offer the reward within two seconds of your pet doing what you wanted it to do, so you need to be prepared! This might seem like very little time and often requires some practice on the part of the trainer, but the quick succession of action and reward is absolutely crucial

▼ **Tortoises may have long memories, which could aid their survival in the wild.**

and so act as if the food had already been handed out.

A third learning mechanism, which is most important for training animals, is called operant conditioning. Here the animal learns to associate its own actions with a positive reward. For example, your reptile could associate a red stick with food and learn to walk across a see-saw every time it is shown the red stick. So what the animal trainer has to achieve is to convince the animal that it will get a reward when it behaves in a certain way.

Equally though, an animal can also learn to associate an action with a negative outcome. It is therefore very important not to do anything that upsets your pet soon after it has behaved in the desired way. If you grab a shy animal every time after it comes to the door of its vivarium for example, it will quickly learn to stay away.

So how can you use these learning mechanisms to train your pet to behave in a certain way or even to teach it little tricks? To have the best chance for success, you need to know how and when to reward your pet and follow a few simple steps. This might sound easy but always bear in mind that teaching animals can take a long time and might require a lot of patience. Do not get frustrated if the learning success does not come immediately. Some individuals learn

for success. Take care not to get flustered though, because scaring your pet in response to an action will have the opposite effect, teaching it to avoid the action that led to the scare.

Finding a reward

Before you can start to train your pet, you need to find a good reward. Rewards can be all sorts of things that an animal desires. Most often, this is food, but for some animals, it could be more helpful to use warmth or shelter. The advantage of using just small pieces of food is that they get eaten quickly and you are more likely to be able to repeat the training steps several times in a row.

Many animals have a favourite food. If you know what your pet likes best, you have already accomplished the first step. Otherwise, you can test what your pet likes best by providing a selection of different types of food at the same time, and observing which one is eaten first. Do not provide too many items at the same time however, so as to not overwhelm your pet.

If there are many options, try combinations of two or three types of food together until you find the treats that appeal most strongly to your reptile. Whether you find that your pet has one or several preferred food items, use these during training and not during normal feeding times. In this way, they remain special and your pet is likely to be highly motivated and will work hard to receive them as rewards.

If food is not an option for rewarding your pet though, you need to find a different method of reward. Many amphibians, for example, are not highly motivated by food but learn successfully when rewarded with



shelter. In this case, providing your pet with a dark, damp hiding place might produce the greatest learning effects. Several reptiles that only eat rarely can be rewarded with heat. Switching on heat lamps in response to a desired action can have a positive effect. However, heat is only likely to be a useful reward for animals that can feel its effects immediately, so it is probably not the best reward to choose for training tortoises.

Next, you have to take into account the task that you would like to teach your pet. Having the animal ending up hidden away in a shelter might defeat the object of your training programme. Sometimes, there might only be one feasible reward option, and you will then have to decide whether this is appropriate for your kind of pet or not. If not, the task itself might not be the most appropriate for your pet either.

Deciding on a task and a cue

This brings us on to the second step you need to take before starting the training of your reptile or amphibian. You must decide exactly and in detail what you would like your pet to learn, as well as the chosen indicator or cue that you will be using to instruct the pet. You have to be very clear about what you expect of your pet, because otherwise you will confuse it rather than teaching it new behaviour. At this stage therefore, it is necessary to be realistic about your species' capabilities and to take into account its physical abilities. You will not be able to teach a salamander to belly-dance but nearly every reptile or amphibian will be able to learn to approach a cue.

This means that you will next have to decide on which cue to use. This could be

auditory such as whistling or a particular spoken word, or it could be visual, as for example a red stick or a green card triangle. It depends on your preference, the nature of the task, and on your pet.

Firstly, you need to make sure that your pet can hear the frequency of your whistle, and is able to see well enough to recognise the visual cue. This is particularly important if you decide to train your pet by using different visual cues for different tasks. As the visual systems of many reptiles are very different from our own, so they might have trouble in distinguishing differences in colour and small patterns in the way that we can. So, choose a cue that is simple, without much detail and only use colours you are sure your pet can distinguish.

Overview: reward choice		
Type of reward	Pet's habits/characteristics	Example taxa
Food	Animals that... • eat regularly • eat food that can easily be delivered directly such as vegetables, fruit, or insects you can provide with tweezers (e.g. mealworms)	• tortoises • herbivorous lizards • larger insectivorous lizards
Heat	Animals that... • do not have a thick shell • desire warmth	• lizards • snakes
Shelter	Animals that... • are nervous • desire dark • desire damp environments (if the shelter is lined with damp bedding)	• salamanders • lizards • snakes

◀ Some amphibians like this White's tree frog can be trained to come on to your hand, if rewarded with food.

A good cue is always matched to the task that you want to teach. If, as an example, you want to teach your pet to come out of its hiding place, then you should use an auditory cue as it is likely not to see any visual cues from its shelter. Should you want to teach it to walk a certain way, perhaps across a bridge, a visual cue is best as you can use it to indicate the path your pet is required to walk.

When using a visual cue as an indicator for a path, it is best to establish a positive association between the cue and the reward first. To do this, show the chosen cue to your pet and then immediately reward it. Repeat this several times until the pet expects a reward when it sees the cue.

Make sure not to overfeed your pet though. Stop before the animal loses its motivation because it is not hungry anymore. The rewards should be small. You can always test if you pet associates the cue with the reward by presenting the cue without a reward while carefully observing the pet's reaction. If it appears to be searching for its reward, then the connection has clearly been established.

Learning step-by-step

Once you have made your decisions about the task and the cue, you then need to prepare the steps that you will teach your pet. If necessary, be prepared to split the task up into small manageable parts. It is too much to expect any animal to understand in one go what you want it to do or, in some cases, even that you want it to do anything at all. Therefore breaking the task up and rewarding small achievements, one at a time, is the key to success.

If the task that your pet is learning is to approach its enclosure door, you would therefore first reward it for looking up and

Bearded dragons can recognise their owners, and learn to relate directly with them.



noting the presence of the cue. Next, you reward it for moving forward slightly. Once this is happening reliably as a response to the cue, you lengthen the distance that your pet needs to move in the correct direction before receiving its reward.

Finally, your pet has to come all the way to the enclosure door before it gets the reward. Once you have decided how to split up the task, then you are ready to start the actual teaching process. If the training area is unfamiliar to your pet, it is useful to let your pet become accustomed to its new environment before you start the training process, so as to minimise stress.

Now it is important to stick very closely to the following order of events: you give the cue, the pet shows the desired reaction, and then you immediately offer the reward! If your pet fails to react as it should, then do not reward it.

Should your pet not show the desired first step in the process after some time, you might have to lower your expectations. Make the first step even easier, always keeping in mind that your pet must be rewarded immediately after the required action has occurred.

Use this step-by-step procedure, so your pet gets the chance to understand slowly and of its own accord what is required to receive the reward. This way, learning is established in an animal-friendly way, which will lead to long-lasting results. Note, however, that you should never stop rewarding altogether. Once your pet is performing the chosen task well, there is no need to reward it every single time but it should still receive a reward for its efforts most of the time, so as to maintain the positive association and keep up its motivation. ❖

Training a tortoise

As an example of what can be achieved, I decided to train my red-footed tortoise, Emily, to walk in a slalom style around some coloured cups. Firstly though, I had to find a reward. As she eats eagerly and has a hearty appetite, so I decided to reward her with food. I then had to test which food she likes best - mushroom, grape, or tomato. Her choice was the mushroom.

So I trained Emily to associate the mushroom with my chosen cue, which was a green and orange stick, by presenting her with the stick and feeding her a piece of mushroom several times. After the association was formed, I fixed on the exact parameters of the task, such as the order of the coloured cups and whether I want her to start by going left or right.

Once this had been achieved, so I let her familiarise herself with the training area. When she was comfortable, I carefully guided her to the left side of the first cup and rewarded her. Next, I guided her a bit further and rewarded her again.

In time, I let her walk further and further before giving her the reward so that in the end, she could walk the entire slalom and would only be rewarded once, at the end of the course. With continued training, she was able to walk the slalom without the presence of the cue while still receiving her reward at the end.



Just remember: be patient, only train when in a good mood, stay realistic, and have fun. Do not forget – training animals is not just entertaining for the owner, but it can also help to enrich your pet's life as well, reinforcing the bond between you.



REPTILE FOCUS

Broadley's flat lizard (*Platysaurus broadleyi*)

The description of 'flat lizard' comes from the profile of these lizards, which are found in southern parts of Africa, living in areas of rocky savannah. Their shape enables them to slip easily into gaps between rocks, effectively eluding predators such as the rock kestrel in this way. Males, as shown here, are conspicuous, because of their bright colouration, whereas females are much more subdued and less vulnerable to predation as a result.

Within the Augrabies Falls National Park, these lizards have become a popular tourist sight, as they leap into the air to catch flies. In fact, they are better-known locally as the Augrabies flat lizard. They also eat fruit, particularly Namaqua figs, and are known to follow flocks of birds to trees where figs are ripe.

Studies have revealed that these lizards typically have more than three times the average number of ultraviolet (UV) light receptors on their retinas, compared with other lizards, which means they are much more sensitive to UV. A further interesting finding, linked to this, is the fact that the dominant males in a group have high UV levels in the vicinity of the throat. This serves as a way of indicating their dominance. Female lay eggs, typically producing two clutches over the summer period.





The risks of handling invertebrates



I have recently purchased a Chilean rose tarantula (*Grammostola rosea*) and a pair of imperial scorpions (*Pandinus imperator*).

Some of the information that I've found says never handle these creatures, whereas other people say that handling is a personal choice. Why is there this apparent conflict, and what is best?

It is really partly a matter of how confident you are, because if you drop these invertebrates – and particularly your tarantula – then you may well cause serious, life-threatening injuries, such as a ruptured abdomen. It does help to some degree if your pets are relatively tame though, since this can make it easier to transfer them to alternative accommodation while you're cleaning out their existing vivarium.

In any event, it should be straightforward to persuade both the tarantula and the scorpions to move into separate plastic containers which can serve as temporary accommodation during this period. This is a safer way of doing things from all points of view, as both these invertebrates are, of course, able to sting. The effect is similar in potency to that of a bee, and obviously not to be recommended.

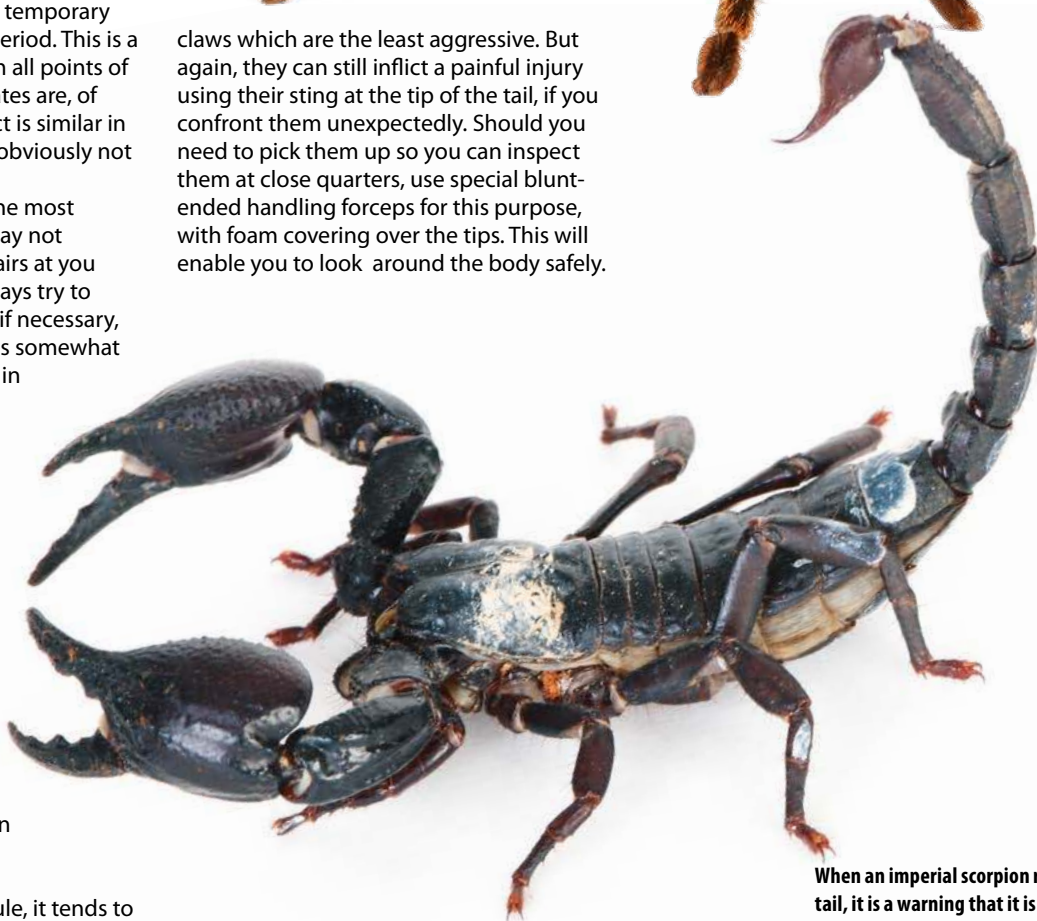
The Chilean rose is one of the most amenable tarantulas, and it may not attempt to flick its irritating hairs at you when you are handling it. Always try to encourage it on to your hand if necessary, because attempting to grab its somewhat fragile body will almost result in injury.

Should you take it out of its quarters, do ensure that other pets are out of the room, and the door is properly closed, as these spiders can move quickly, and catching them here may not be easy. They may even manage to disappear and if not located quite quickly, they can die from dehydration. It is better to look at a tarantula therefore, rather than risk handling it out of its quarters, except in an emergency.

Imperial scorpions, too, are generally quite placid – as a rule, it tends to be those scorpions with the largest

claws which are the least aggressive. But again, they can still inflict a painful injury using their sting at the tip of the tail, if you confront them unexpectedly. Should you need to pick them up so you can inspect them at close quarters, use special blunt-ended handling forceps for this purpose, with foam covering over the tips. This will enable you to look around the body safely.

A Chilean rose tarantula. Rearing up in this way is also a sign of aggression.



When an imperial scorpion raises its tail, it is a warning that it is poised to sting.

Reading the right clues on the map



I bought what I thought were two Mississippi map turtles last year, but

the markings on their bellies have all gone so I'm a bit unsure of what they are. I've asked at reptile shops and they said that they could be another type of map turtle. Is there any way of finding out what they are? I have also noticed that they don't get out and bask for long. They just plunge into the water and hide if they hear or see you; is this normal? Or could it be because I don't have any decor in my tank?

Mississippi map turtles (*Graptemys pseudogeographica kohni*) have a fairly indistinctive patterning on the top of the shell, with the background colour being greyish-brown. There will be a slight blackish line running down the centre here as well, with an evident raised area or 'keel'. The body colour is light grey, with yellow stripes. The underside of the shell is not that significant in determining their identity, with dark patterning here being a variable feature.

Instead, look closely at the sides of the face. There should be a yellow band that curves down from the top of the head, extending behind and below each eye. The eyes themselves are also a useful identifying feature, with the pupils being rounded in shape in this case, usually with no bar running horizontally across them.

The nearest relative of the Mississippi map turtle is the false map turtle (*Graptemys p. pseudogeographica*), which tends to have an elongated spot behind the eye, although stripes from the head extend to the eyes. A similar situation applies in the case of the common or northern map turtle (*G. geographica*), where the distinctive crescent associated with the Mississippi race is again missing. A further point of distinction in this case is that the keel extending down the centre of the back is much lower.

The nervous nature of your map turtles is partly instinctive, but is also probably being



emphasised by the lack of tank decor. You can overcome this to some extent by incorporating aquatic plants like duckweed, which will spread rapidly over the surface of the water, providing cover and possibly an additional source of food for the turtles as well. They should then feel sufficiently secure to put their heads up out of the water, slipping back under the water when you approach, rather than swimming around wildly.

The other thing that you can try to win their confidence is to hand-feed them, by holding a mealworm just above the surface for them. Do not worry too much if you find that one of them starts to become much bigger than the other. This is simply a sign that you have a pair, as in map turtles generally, females will grow significantly larger – often being double the size of their mates.

Mississippi map turtles are relatively aquatic, but they should come out and bask at intervals. This is important for their health, helping them to shed their shell scutes. Position a suitable full spectrum light here over a dry area of the tank, where they can move easily in and out of the water. A turtle basking platform is a useful option for this purpose, attaching to the side of their enclosure.

▲ The northern map turtle has a relatively smooth shell, with no raised central area.

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The forgotten king

The Florida kingsnake (*Lampropeltis getula floridana*), or brooksi kingsnake as it is also known, has tended to be overlooked in the past, writes Neil Little. It occupies third place behind both its popular west coast relative, the California kingsnake (*Lampropeltis getula californiae*) and the mountain kingsnake (*Lampropeltis pyromelana*). But now, however, I sense that things are about to change!

In North America, breeders specialising in Florida kingsnakes, notably Rainer Waisenpaul who is located in Georgia, have created some stunning morphs which are set to rock the kingsnake world. At present, there are only a handful of breeders working with them in Europe, but the popularity of these snakes is increasing here too, as more people fall under their spell.

In my opinion, even the normal form of the Florida kingsnake is stunning, and the individual variability of these snakes is so marked as well, which adds to their uniqueness and appeal. They range from dark specimens which are almost black in appearance, apart from white and yellow speckling across their dorsal surface, originating from more northerly areas, through to really light specimens that are almost pale yellow with very little black speckling. These come from southern parts of Florida.

Now with addition of morphs such as the peanut butter and jelly, so even more individual colour variations are possible in Florida kingsnakes. The opportunities are endless and it is no exaggeration to say that before long, we could start to have as many



Peanut butter morph.

varieties as exist in the case of corn snakes.

Why the Florida form?

These snakes offer something for everyone, ranging from the beginner hobbyist to the absolute expert. They

are very easy to care for, rarely fall ill and will never miss a feed. They do not grow very big but develop into a nice, solid, chunky snake just a bit larger than a Californian kingsnake. The best thing about them is they do not seem to have the same need to bite

everything that comes into contact with them - unlike their west coast relatives!

I have many Florida kings in my collection and have not been bitten once as yet, although I appreciate when keeping any snake that a bite will be inevitable at some stage. They occur in the wild from central to southern parts of Florida with isolated populations in the northeastern and Panhandle areas of the state.

The description *L.g. floridana* is the recognized nomenclature for this subspecies. Nevertheless, specimens from southern Florida, in the vicinity of Dade county, are frequently referred to as 'brooksi', explaining why two names are in use in the hobby.

These specimens from Dade county are usually very light in colour, almost resembling a hypo morph, and distinct in appearance from *L.g. floridana*. Rather ironically, given the restricted range of these particular kingsnakes, there is a general tendency now to refer to all Florida kingsnakes as brooksi!

Care requirements

Florida kingsnakes are relatively easy to care for in captivity, being no more demanding than corn snakes or California kingsnakes. They are very suitable for novice snake-keepers. Even when young, they tend to be less nervous and more outgoing than other kingsnakes or milk snakes.

Some display in a threatening way, like coiling up in a strike pose whilst not actually striking in any way. This is more of a bluff, hoping to persuade you to go away. They may sometimes wag their tails too, not like a dog, but to express their annoyance. There may be some mimicry in behaviour here with rattlesnakes, as they can make a similar sound.

I keep my collection in a rack-type set-up as I have a large number of snakes and limited space, but this works well for both me and my snakes; they are healthy, feed very well and breed. Like many other keepers, I use Really Useful Boxes, often better-known in the hobby as RUBs. My Florida kingsnakes are housed in the 33L size of box, as part of a lid-less racking system.

If you have space or like to display your snakes, then I would use a vivarium of around 1.2m (4ft) in length. Avoid a larger enclosure as I tend to find that snakes prefer a smaller range to move around in,



▲ Snow morph.

rather than large open spaces. It makes them feel more secure. I have also noticed some snakes will not eat for this reason, but once placed in a smaller tub or vivarium, their appetite returns within a few days.

I use Aspen snake bedding as a substrate. It is very good at absorbing waste and does not smell, but you could also use newspaper as my brooksi tend not to burrow anyway. It all depends on what your personal preferences are, and also the effect that you want to create, in a vivarium. I have also used a substrate called Aubiose – it is a type of horse bedding made from shredded hemp. It is cheap and also does a very good job.

I tend not to place a hide box into the enclosure because the rack effectively acts like a big hide box. The only time that I use a hide is for my females when they are due to lay. A water bowl is placed within the enclosure at the cool end and that is all. It is a very simple set-up but is very clean, effective and easily maintained. If you are displaying your snake in a vivarium set-up, then of course, it can be as elaborate or as simple as you wish to make it, incorporating plants, hides, rocks and even waterfalls!

Heating and lighting

For heating my racks, I use heat cable which sits and runs at the back and bottom of each tub. It is connected to a thermostat, creating a "hot end" temperature of around 30°C (86°F) and a "cool end" of about 26°C (78°F). This works well for me with cycling the snakes for breeding, as the temperature in the room where they

are housed also fluctuates with the season, creating more of a natural cycle.

As for lighting, I do not use any light source within the racking system as this is not practical due to the space. Natural light comes in through a window illuminating the room however, and serves to create a natural light cycle, varying through the seasons. In a vivarium, you could use a spot light/heat lamp which will give you a combined source of light and heat. Alternatively, heating can also be provided by a suitable heat mat or ceramic heater designed for the vivarium. I would strongly recommend the use of a thermostat to regulate the heat output though, and protective screening on any lights.

Feeding

When it comes to feeding, I do not think you will ever encounter a problem with this species of snake. They are always eager to accept food! Mice or rats are readily accepted as a staple diet. I offer mice to mine, depending upon the size of the snake, but the size of the prey is also significant. I tend to feed my kingsnakes on slightly larger mice but with a longer period of time between feeds - typically every 10 days as opposed to seven days.

I have not tried using them yet, but soon I will be introducing multimammate rats (*Mastomys* species) as a food source for my kingsnakes. They are an African rodent that is becoming very popular amongst reptile keepers, and I am sure there will be no problem with a switchover. I am also considering using chicks to enhance and add more variety to their diet. ❖



All the king's colours

With the popularity of Florida kingsnakes having grown significantly over recent years, it was inevitable that more colour varieties or 'morphs' would emerge. Their development is largely due to the efforts of one dedicated US breeder called Rainer Weishaupl. Neil Little explains more about the available colour varieties, and gives a glimpse as to what is still to come.

The only colour choices that were originally available were the normal form and a naturally-occurring pale or 'hypo' variant. Snakes of this colour were a very light, creamy yellow and originated from an area of Florida known as Dade County. They were thought to be a separate species which is why they became known as 'brooksi', as distinct from 'floridana'.

Further studies have now proved this is not the case, but the tradition has grown up, and so now enthusiasts generally refer to Florida kingsnakes as brooks kingsnakes and brooksi morphs. Another type of hypo was found by Bill and Cathy Love, which was a very light specimen with greatly reduced black pigment. This then proved to be the turning point, marking the start of the rapid development of brooksi morphs.

I was an early convert to the beauty of Florida kingsnakes, even the normal form which is a beautiful snake in its own right, and has a highly variable appearance. Nevertheless, there are now all the following morphs that exist as well.

Hypo

Snakes of this colour are descended from the Dade County adults found by Bill and Cathy Love.

They stay a creamy-yellow shade throughout their life, generally becoming lighter as they reach adulthood. Hypos have since been bred with other morphs, including axanthics to create so-called ghosts. Hypo flames are also becoming popular too. These are very similar pattern-wise to the hypo itself, but retain large amounts of red colouration into adulthood.



Anery

A dark black and grey snake, with a variable pattern, the anery is one of my favourite morphs. They have been used to create classic snows and when combined with the peanut butter (Pb) gene, this has given rise to one of the newer morphs, called the phantom.



Axanthic

There are currently two forms of axanthic in the case of the Florida kingsnake - the classic axanthic and also the New England axanthic. However, these are not compatible when bred together, confirming that they are distinct mutations. The original axanthic is a much darker snake and does not seem to be used as much as the lighter New England variant, which is especially beautiful, having a purple or blue sheen on its body. Axanthics have been used to create ghosts and the pewter form.

Lavender

Considered to be the T+ form of an albino, this is a very pale snake – currently being sold in the UK as albinos although these are not the true amelanistic form. Lavenders are pale cream and white as adults, being pretty in their own right. They are valuable for breeding purposes too, as they can be combined with the anery form to create snows in due course.

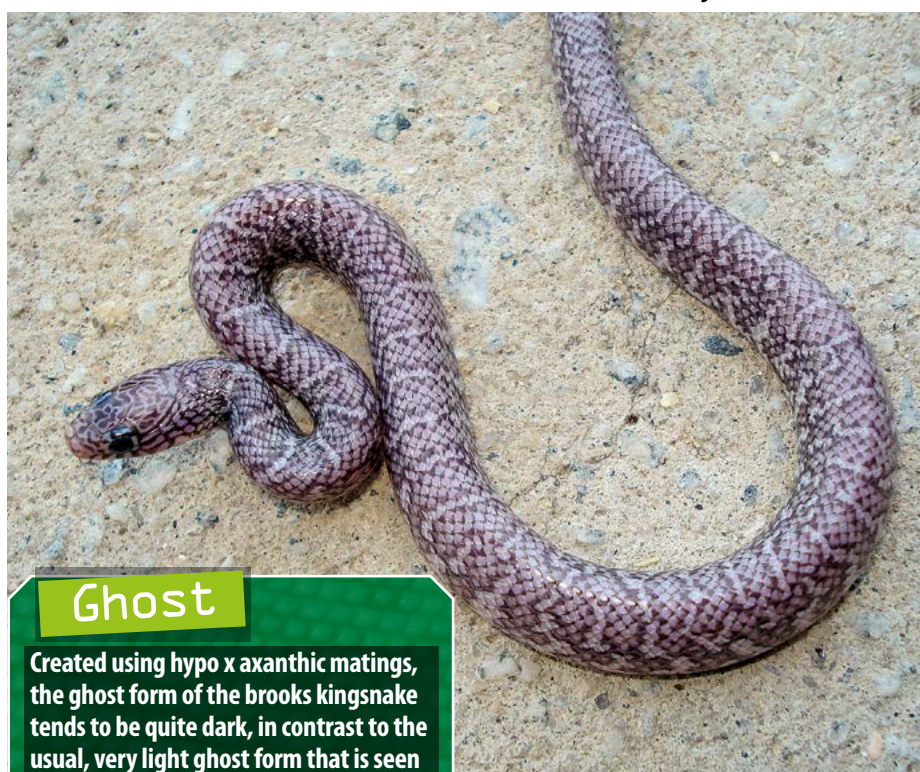
T- albino

The T- form has true red eyes, with the original group of these snakes being purchased in the early 1990s from a zoo in California by Rainer. They were known to be the only T- albinos in existence at that time, but their origins were a mystery. T- albino offspring have varying amounts of red, with high red specimens being bred to hypos so as to create hypo flames, as mentioned earlier. They are still quite a rarity in the hobby as people who breed this variety tend to keep them, because they are useful in terms of creating other morphs.



Sulphur

A very nice-looking, bright yellow snake as its name suggests, with some individuals having varying amount of an orange hue on their bodies. When combined with other colour varieties, the sulphur mutation helps to accentuate the colours in other morphs, especially red and purple-lavender.



Ghost

Created using hypo x axanthic matings, the ghost form of the brooks kingsnake tends to be quite dark, in contrast to the usual, very light ghost form that is seen in other snakes, and they seem to have a very busy pattern as well.

Snow

The first snows were the result of T+ albino x anery pairings. These have a very pale colour and patternation. Although they have red pupils, they were not bred using true albinos. Breeders have now started using the T- albinos to create some truly stunning snow morphs.



■ I truly believe this group of kingsnakes has been overlooked for far too long, but their popularity is set to increase significantly. There is plenty of scope to produce more morphs – possibly in numbers even rivaling those of the corn snake in a few years time! ■

Peanut butter (Pb)

These originated from a wild-caught male found by Rob Roy, and a female that was discovered by Bill and Cathy Love. These snakes were both unusual-looking specimens and were mated to produce the first hets. These were bred back to each other and the first peanut butter was produced. I am not too sure why the name stuck, but it might be due to the fact that the colour of the snake resembles that of peanut butter spread!

When they hatch, youngsters are very bright in colour at first, but they then turn a lighter colour into adulthood, acquiring their distinctive colouration. This morph has played a very significant part in creating other morphs. It seems to be compatible with other genes, thereby creating spectacular-looking Florida kingsnakes and also makes existing morphs appear even more attractive - plus there is further scope with these to create additional colour forms too!



Jelly



This morph was created by breeding a peanut butter with a T- albino, leading to the appearance of this new variant in the first generation. Interestingly, it appears the Pb gene shares an allele with the T- albino, explaining the creation of the jelly morph. This only works with the Pb and T- pairings; crossings involving Pb and T+ snakes were tried but the resulting offspring all appeared as normals.

Some breeding outcomes using the jelly gene

Jelly x T- = ½ albino ½ jelly
Jelly x Pb = ½ jelly ½ Pb
Jelly x jelly = ¼ T- , ¼ Pb and ½ jelly
Jelly x normal = normal hets

Pewter

Another form created using the Pb gene, but this time in combination with the anery. The result is a very pale, almost silvery pink background colour with a very reduced pattern - but the really striking thing about this snake is its solid black eyes!



Phantom

The result of Pb x axanthic matings, the phantom is a white snake, with black patternation, which is significantly reduced to pale grey.



Golden Pb



Another triple het breeding, but differing from the peabino, with anery replacing albino in its ancestry. It displays the Pb pattern although along the sides, the markings seem to break up and it has a cobbled high red/flame orange appearance with striking head markings, and white cross bands. These particular snakes are absolutely stunning, as hopefully this picture indicates.

Albino snow

Bred as the result of true albino T- x anery pairings, albino snows are very striking, displaying a very pale pattern on what is otherwise a white snake.

Peabino

This is a triple het snake, being a combination of Pb x lavender x albino. It is a stunning morph, being a very bright red, with purple lavender accents.

Sulphur lavender



The product of a T+ albino x sulphur cross, the sulphur lavender has a blue/pink hue base colour but with a very bright orange/yellow broken saddle pattern across the dorsal area.



Mosaic

The result of a simple recessive pattern gene, mosaics vary colour-wise from dark to cream with busy patternation. Breeders have started introducing this characteristic into other morphs but there is plenty of scope to experiment with this type of pattern, resulting in possibilities such as the mosaic peanut butter.

Sulphur snow

This morph was basically created from a sulphur x snow pairing, so in effect, it is a triple het animal: sulphur x albino x anery. The sulphur snow is also a very beautiful snake - the sulphur brings out the colours and in this case, the patternation takes on a bluish tinge, creating the effect of ice.

Bone white hypo

This is a white snake with very little pattern, being very similar to the high white cali kingsnake but with an even more reduced pattern. It also seems to be the result of a dominant gene. Males tend to turn a yellow colour whilst females are bone white. This is currently a very sought-after variety. There are not many around and when available, they sell very quickly, being very reasonably priced, given their scarcity.

The future

I am convinced that very exciting times lie ahead with this rather forgotten and not widely-kept kingsnake, especially now that morphs are becoming much more common, with their development continuing rapidly. As an example, the first quad het brooks has

been created, and this morph is now known as the abelescent.

Also amongst the recent additions to the scene are striped Florida kingsnakes and albino mosaics. These are very attractive too, with this patterning adding to the variety within this group.

In conclusion

Only a few years ago I did not have any brooks kingsnakes in my collection but after seeing some pictures on Rainer Weishaupl's website, I was instantly hooked and I knew that it was a direction I wanted to head in, as a breeder. I now have a rather large collection comprising of most of the colour morphs available and have helped to create the peanut butter and jelly morphs!

The potential is enormous and exciting, so far as breeding is concerned. These kingsnakes are not only beautiful, but they are also highly variable in colour and pattern. The head pattern on each snake is so different and stunning, which helps to make them very individual, and they change in appearance from hatchlings to adults. They are also easy to care for, making them the perfect kingsnake! ❖



Striped.

Styling counts

When it comes to deciding how you want to decorate your vivarium, there are various factors to bear in mind - but most importantly, the needs of the species that you are keeping should be uppermost in your thoughts, as Greg Jennings explains.



Crested newt larva underwater.

The first thing to remember, when styling a vivarium, is to know as much as possible about the animals that you are intending to keep. Most geckos for example are well-equipped to climb, thanks to their extended toe-pads, which enable them to climb vertical surfaces, including glass, with little difficulty. They therefore need to have branches arranged accordingly, allowing them to benefit from the height of their quarters. Yet this does not apply to all geckos - the popular leopard gecko (*Eublepharis macularius*) for example lacks toe pads, and spends much of its time on the ground, adopting a hide here where it can spend much of the day, before emerging at dusk.

As a general guide, when it comes to selecting retreats for both reptiles and amphibians, they prefer snug quarters where they can feel secure, rather than a larger open area. In some cases, it may be better to provide a choice of hides as well - this can be recommended for lizards which may be inclined towards being territorial, by lessening the likelihood of possible conflict.

Otherwise, the resulting stress can trigger a loss of condition and even illness, especially over a period of time. This is why it is so important to design all aspects of the vivarium to correspond to the requirements of



▲ Leopard geckos are not great climbers, but benefit from securely-balanced low rocks in their quarters.

the occupants. If you want a natural-looking hide, then cork bark can be used for this purpose, providing that you can find suitable pieces. As a natural product, it does vary in its shape.

Aquatic decor

The same applies in the case of aquatic creatures as well, where rockwork is especially important. This may be used to allow turtles or frogs perhaps to emerge on to land. The edges in this case need to be smooth, so as to

prevent the risk of injury, and the rocks themselves must to be arranged in such a way that they will not collapse, as this would otherwise have serious if not fatal consequences for the tank occupants.

Equally, all decor in an aquatic set-up needs to be positioned in such a way that it will not interfere with the action of the filter. Having a large area covered by rockwork for example will block off the action of an undergravel filter, while locating a power filter behind rocks will reduce

its effectiveness, in terms of sucking up water. This is an advantage of using a landing platform, which effectively floats at the water's surface, without affecting the movement of the water in the tank.

Ornaments

There are a number of ornaments that you can introduce to an aquatic set-up, and the choice is largely a matter of personal taste. If such items are being marketed for fish, then they should also be safe for reptiles and amphibians, but be more wary with other items which may be in use around the home, particularly if they could have been contaminated by chemicals.

Do not forget that even in these surroundings, newts for example will often seek to retreat into cave-like structures, which can be created with a small, new clay flowerpot. An empty pot which has been used previously, however, may have been contaminated by pesticide residues as an example. It is therefore better to purchase objects that have been specially designed for use with reptiles and amphibians.

Even so, it is misleading to think that such items are suitable for all species. Most turtles are quite cumbersome when swimming, and will knock over objects in their path, as well as uprooting plants. A plain base to their tank is therefore usually recommended.

Planting up

Plants themselves can also be harmful to vivarium occupants under certain circumstances. It is not recommended to include live cacti in a desert-style vivarium, although these may be part of the natural flora of the region where



▲ Red-eyed tree frog resting on leaves.

your chosen species of reptile would be found. Even if the cacti do not harm the occupants, they can easily catch your hand or arm when you are attending to their needs. In this case, the best choice may be to opt for a plastic substitutes.

Equally, there can be problems trying to grow live plants, with the aim of creating a rainforest-type environment on a relatively small scale within the confines of the vivarium. On one hand, the plants may die back, and their leaves will be attacked by mould, which might itself harm the vivarium occupants, quite apart from appearing

unattractive. Conversely, the plants may otherwise thrive to the extent that they soon become too large for the vivarium, and so will need to be cut back and replaced, which is also not ideal.

It is possible to obtain plastic plants with a very naturalistic appearance, which can be positioned to disguise other unsightly vivarium features if necessary, but also vines and other items, which are both attractive yet functional, being used by species such as chameleons and tree frogs of various types. These are often fully submersible too, making them popular with more aquatic amphibians as well. Artificial hanging plants are another option, which can be trailed down to give cover over an area within the vivarium, and these are generally very easy to clean.

Humidity and background

The need for being both attractive and functional also applies in the case of both waterfalls and mister units, which will help to raise the relative humidity in vivarium surroundings. Gone too are the days when the vivarium background consisted of no more than a printed sheet stuck on the back of the glass. Today, backgrounds can be used as an integral part of the vivarium set-up, as typified by those in the Exo Terra® range. These can serve to conceal unsightly wiring, as well as providing a climbing surface for the occupants too in some cases. ❖

▼ Humidity in the vivarium can be vital, but not all plants will thrive under these conditions. This monkey frog tadpole is metamorphosing into an adult frog.



Humidity in the vivarium can be vital, but not all plants will thrive under these conditions. This monkey frog tadpole is metamorphosing into an adult frog.

Understanding metabolic bone disease

Young leopard geckos are likely to benefit from exposure to UV (ultra violet) light.



As the number of reptiles kept as pets has increased, so too has the frequency of husbandry-related illnesses. Although it is easy to blame this on basic ignorance or misunderstanding of specific care requirements for particular species, the situation can be more complicated, as Dr Andy Tedder explains.

Firstly, there are certain species which are particularly vulnerable to these health problems, and also specific groups within a species, such as young or breeding animals which are at greater risk. The problem itself may be complex too, as typified by metabolic bone disease (MBD). Its name suggests a single cause, but in reality, this is something of an umbrella term, and its complex nature may help in part to explain the prevalence of cases of this nutritional disease.

Put simply, MBD refers to skeletal abnormalities caused by calcium (Ca) deficiency. Ok, so why is calcium so important, and what exactly does it do within the body? Calcium is responsible for a large number of processes within the body, including:

- Growth and maintenance of calcified structures like teeth and the skeleton;
- Muscle contraction in various types of muscle tissue including the heart;
- Nerve impulse conduction, both to and from the brain and spinal cord;
- Blood coagulation;
- Cellular movement.

What is quite clear from this list is that calcium does have a very significant role to play within the body, and that a deficiency can have profound, far-reaching effects, that perhaps many people did not realise.



◀ The weight of the tongue can cause distortion of the lower jaw in cases of MBD.

1. Metabolic bone disease caused by excessive phosphorus.

Generally speaking, reptile metabolism favours a calcium:phosphorus (Ca:P) ratio of equal to or greater than 2:1. When the diet contains too much phosphorus relative to the calcium content, then the body will take measures to readdress the balance. Calcium will be taken from various sources throughout the body starting with blood plasma, and then calcified tissue, particularly bone, with this process being triggered by hormones.

What it is important to note is that unless the calcium is replaced, the tissue from which it was removed will remain deficient in this vital



◀ Crested geckos are vulnerable to MBD.

Important!

A UV tube will become less effective over time, without appearing so visually. A good rule of thumb would be a tube without a reflector will have a lifespan of between 6-8 months. A tube with a reflector will have a lifespan of 12 months but read the manufacturer's guideline too. It is possible to measure and monitor the UV output using a Solarmeter®.

mineral, with the bones for example becoming weaker and gaining a rubbery texture. Calcium stripped from the skeleton passes into blood plasma and other tissue fluids, before eventually being lost through the urine, worsening the situation. Firm evidence about timescales for this process at present do not exist, and this of course makes it difficult for keeper to address.

Early symptoms of this form of MBD include:

- Swelling of the limbs; this is particularly evident in crested geckos (*Rhacodactylus ciliatus*)
- Disfiguration of the lower jaw.

Interestingly both the upper and the lower jaw will suffer the same rate of bone softening. However, due to the force exerted by the musculature of the tongue, the lower jaw develops the characteristic bowed shape.

▼ Water dragon juveniles are fast-growing, making them susceptible to MBD.

In extreme cases, other symptoms can include;

- Muscular spasms
- Twitching
- Paralysis

2. Metabolic bone disease caused by insufficient vitamin D₃.

It comes as a surprise to some owners that reptiles with sufficient dietary calcium can still suffer from MBD. The reason for this is the lack of either dietary or environmental vitamin D₃. This vitamin is essential for calcium absorption via the intestines, and is generally synthesised by animals when exposed to sunlight or artificial UV light. Nocturnal animals also need a source of vitamin D₃, and this is usually supplied by appropriate supplementation.

This type of MBD, historically known as 'rickets' is characterised by weakening of the bones, and also cartilage overgrowth, which presents as swelling around the joints known as 'rachitic rosettes'. Bone fractures are particularly common in this instance.

3. Soft tissue mineralization caused by excessive Vitamin D₃ and excessive calcium.

Although it is clear that reptiles require both an external source of calcium and external source of vitamin D₃ to remain healthy, 'more' is not always better. When an excess of both calcium and vitamin D₃ are present in the system, the animal can develop soft tissue damage. The problem occurs because the blood calcium level rises to such an extent that deposition of calcium into muscle tissue begins. This condition is known as hypercalcemia. The range of organs and tissue which this condition affects makes it very dangerous, with key organs such as the heart, lungs, kidneys and bladder being amongst the most common, as well as major blood vessels.

What becomes apparent is that both calcium and vitamin D₃ play a vital role in the health and well-being of your animal, and that an appropriate balance must be achieved to maintain not only healthy bone growth, but also to prevent calcification of muscle



tissue. With this in mind, the diet of each reptile species becomes very important.

Ca: P – getting the balance right.

Correct nutrition can mean the difference between a healthy or sick animal. All reptiles have the potential to suffer from any of the forms of MBD, and so ensuring the necessary dietary components are present is very important. Table 1 shows the ratio of calcium: phosphorus in some commonly-offered fruits and vegetables. What is significant here is that this table affects both insectivorous reptiles and herbivorous reptiles, as correct gut-loading of insects is very important, being influenced by the foods they are being offered.

UV light and dietary vitamin D₃.

The role of vitamin D₃ as both a preventative and yet also potentially a cause of the various forms of MBD means that correct dosage is essential. The exact method by which you provide this for your animals will vary depending on its other husbandry requirements. For example, a diurnal reptile such as a tortoise or iguana will require a source of UV light, and so its additional dietary vitamin D₃ requirement will be lower (relatively) than that of a leopard gecko or other nocturnal species.

Kale is a member of the brassica family.

Table 1. Foods and fruits along with their calcium: phosphorus values.

Negative Foods	Ca:P	Positive Foods	Ca:P
Banana	1:3	Broccoli leaves	4:1
Broccoli florets	1:1.6	Broccoli stems	2.5:1
Brussel sprouts	1:4.5	Cabbage	6:1
Cucumber	1:2	Chard	6:1
Grapes	1:2	Collard greens	2.75:1
Lettuce	1:2.5	Dandelions	2.5:1
Mushrooms	1:7	Kale	3:1
Tomatoes	1:2.5	Mustard greens	3.5:1
Corn	1:13	Watercress	3.5:1

From the table, it is quite clear that some vegetables are better than others, and perhaps some should be avoided altogether. The key as ever is in balance, particularly as some of the brassicas such as kale, with a high Ca:P ratio nevertheless have other nutritional shortcomings, which restrict their usefulness as reptile food.

Are certain groups or species more at risk?

While all types of reptiles can be at risk from MBD, breeding females of all egg-bearing (oviparous) species are especially vulnerable. The calcium requirement of breeding females is much greater than that of males of a similar age, due to the calcium required for their eggs. For this reason, it is usually recommended to adapt your feeding and supplementation regimen to compensate accordingly.

Other 'at risk' groups include species which have a particularly fast-growing juvenile stage like Chinese water dragons

(*Physignathus cocincinus*). Crested geckos (*Rhacodactylus ciliatus*) also deserve a special mention. They appear to be unusually susceptible to MBD, especially when kept on a diet primarily consisting of insects. Although this species is nocturnal, it is for this reason that I would suggest the use of a low level UV bulb (2 per cent UVB) for a couple of hours daily.

What to do if you suspect your animal is suffering with MBD.

Unfortunately, MBD is becoming quite common, and the early signs can be tricky to spot unless you know what you are looking for. If in doubt, always consult a reptile vet, they will be able to evaluate the situation fully in an individual case, and, taking into account both the symptoms of the animal and husbandry details, they will be able to help you make improvements.

MBD is treatable in most cases, but unfortunately, its effects are often irreversible. This means that if your animal is presenting quite severe symptoms such as a bowed jaw, this will not revert to its original state, but it will be prevented from getting any worse. Early diagnosis of the problem is therefore very important in the longer term.

The best advice I can give to anybody with concerns is to read as much information about reptile husbandry as you can, and talk to breeders and fellow enthusiasts. Providing the right nutrition and environmental conditions for your animal really is key to ensuring its health. ❖



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400mm / 16"	29°C	36°C

Why not consider White's?

White's can climb well, thanks to their swollen toe-pads.

Looking for a tree frog with a friendly, docile personality that has a cute, dumpy appearance and is easy to maintain? Hannah Salisbury BSc (Hons) AnSci provides an introduction.

White's tree frogs (*Litoria caerulea*) have a well-deserved reputation as being the most popular tree frog for hobbyists new to keeping amphibians. They are so-named in honour of John White, the naturalist who first identified and described this species back in 1790. These particular tree frogs are to be found in north-eastern Australia and south parts of New Guinea, where they favour humid and tropical rainforest-type environments. Since then, the species has been introduced to parts of the south-eastern USA, notably Florida. There was also a small population that used to be found in New Zealand, but it is now thought to have died out.

These tree frogs first became popular as pets in the early days of the hobby, back in the 1970s, initially in the USA where enthusiasts quickly discovered that these hardy amphibians made excellent and entertaining vivarium subjects that bred readily and could live for 15 years or more if kept in suitable surroundings. Soon after, captive-bred baby White's started to become widely-available in Europe, and became hugely popular as relatively inexpensive exotic pets.

White's are quite a large and robust species of arboreal tree frog, with adults reaching between 7.5-13cm (3-5in) in length. Females tend to be slightly bigger than males once adult, and healthy specimens often have a podgy appearance, hence their nickname of 'dumpy tree frog'. Like many tropical amphibians, these frogs also have the ability to change their skin colouration in accordance with their surroundings.

Their appearance is influenced by a variety of factors such as humidity,

■ If you do decide to use live plants, select species that are sturdy and resilient so they can stand up to the weight of the frogs jumping and climbing on them. ■

temperature and light exposure, and can vary from a lush apple green to deep earthy brown. Occasionally, vivid shades of blue and turquoise may be evident, often with white or yellow speckles along their flanks and creamy-coloured undersides. Those with extensive white areas are described as peds, while those displaying white speckling are now known as snowflakes.

White's tree frogs have broad heads and olive or brown-coloured eyes with horizontal irises. The parotid glands, which produce a protective liquid secretion that is rubbed over the skin, can be seen as large, smooth bulges above the tympanic (ear) membrane on either side of the head.

Males possess a characteristic raucous call, which can often be heard in response to music or the sound of rainfall, when claiming territory or courting a mate. Females will also call occasionally, but this is usually in response to some form of irritation or distress, and is usually more like a deep 'squeaking' compared to the males' more distinctive 'barking'.

Housing

White's tree frogs can be housed in pairs or small groups in large, arboreal-style glass terrariums. An adult pair will require a minimum space of 45 x 45 x 60cm (18 x 18 x 24in), although a bigger terrarium will be appreciated by these frogs. They tend to sleep during the daytime but become exceedingly active at night and when they are being fed. Like most amphibians, White's are very sensitive to noise and vibration, so the terrarium should be positioned in a quiet area of the home away from TV speakers or stereos, as well as out of draughts and direct sunlight.



▲ A large head and a correspondingly broad mouth are characteristic features of White's tree frogs.

The terrarium itself should be furnished with a deep layer of humidity-retaining substrate such as coco fibre mixed with coarse grade orchid bark, and decorated with a variety of sturdy branches for the frogs to climb and bask on. Artificial plants are often used with this species, as being so heavy and often clumsy in the way they move, White's tend to crush and trample live plants.

Artificial silk and plastic plants can be bought relatively inexpensively from reptile supply stores, and an attractive rainforest-type environment can be created incorporating realistic vines, bromeliads and orchid and lily flowers. The advantage of using such foliage is that it can be removed and cleaned

easily, and will not wither and die, although even these substitute plants may end up looking a bit tatty after a few months of being squashed by the frogs!

If you do decide to use live plants, select species that are sturdy and resilient so they can stand up to the weight of the frogs jumping and climbing on them. Large bromeliads often work well, while sphagnum moss on the floor or background of the terrarium is always useful in retaining humidity. All live plants should be thoroughly washed and repotted into a fertiliser and pesticide-free growth medium as sold for reptiles and amphibians before being placed in the tree frog terrarium.

A large water bowl should be positioned on the terrarium floor and cleaned and refilled with dechlorinated water every day, and the glass walls of the enclosure should be rinsed down at the same time. This is of particular importance in the case of White's tree frogs, as they are susceptible to developing fungal infections and the bacterial skin disorder known as 'red leg', which is associated with dirty water bowls and terrarium conditions.

Humidity levels inside the terrarium should be maintained between 45-70% which is best achieved by misting the enclosure lightly each day or as often as needed in warmer weather using a hand-held spray bottle. Once again, only dechlorinated water should be used for this purpose, with the humidity level being measured with a hygrometer.

▼ These tree frogs will benefit from UV lighting in their quarters.





Illumination

Lighting is usually provided by means of using a terrarium-specific canopy lighting system, or using dome reflectors over the mesh top of the enclosure. A low-wattage basking bulb such as the 15 or 25W Exo-Terra® Sun Glo bulbs can be used to maintain an ambient temperature of 24-28°C (75-82°F), with a warm basking spot of around 29°C (85°F) during the daytime, allowing for a 3-4°C (5-7°F) drop at night.

As for UV lighting, for many years it was believed that tree frogs in terrarium surroundings would thrive and breed without exposure to full spectrum ultra violet lighting. Recent research carried out over the past couple of years, however, is now pointing to an ever-stronger indication that many tropical and semi-tropical species at least do need daily UV light in order for vitamin D₃ synthesis and therefore correct calcium metabolism to take place, and for the regulation of the frogs' biological clocks.

I would therefore recommend using a 5% full spectrum UV compact bulb or full-length fluorescent tube for a photoperiod of 8-10 hours per day for White's tree frogs, although the frogs should always have access to a shady area in which they can rest away from the light if they so choose.

Diet

White's tree frogs love nothing more than eating, and are not exactly fussy about what they can fit in their mouths. A varied diet of gut-loaded brown crickets, small locusts, waxmoths,



▲ These tree frogs will sometimes hunt on the ground and they should be encouraged to move around their enclosure.

mealworms and earthworms should be provided with twice-weekly supplementation using a broad-spectrum vitamin and mineral formula such as VetArk's Nutrobal on one feed, and a tree frog specific formula such as Komodo's Tree Frog Insect Dusting Powder sprinkled over the next.

All insect prey should be gut-loaded, by being fed on a mixture of bran, crushed cat biscuits or fish flake food and grated carrot to maximise their nutritional value. This in turn will then help to provide the full complement of micro and macro nutrients that the frogs require. Adult White's tree frogs will do well on 2-3 feeder insects every other day, and should be offered food in the evening when they are just waking up and becoming active for the night.

You should encourage these tree frogs to hunt for their food by releasing feeder insects into the enclosure so that they have to search and explore to find their meals. You can monitor the frogs' body condition by looking at the pad of fat on the head where the parotid gland is located.

In a healthy frog, this should be plump and round, but if it becomes so large and flabby that it begins to hang down over the tympanic membrane and eyes, then this is a sign that the frog is becoming dangerously overweight. Its food intake should be gradually restricted until it reaches a healthier body condition.

It is also worth pointing out that their ferocious appetites are the main reason why White's tree frogs are not at all suitable for housing in community vivariums – any smaller frogs and lizards sharing their habitat will be seen as prey and almost certainly eaten. The same will apply to smaller individuals of their own kind.

Breeding conditioning

White's become sexually mature at two years old, although ideally, you should



▲ This individual is starting to gain weight, as shown by the flabby pad extending over the rounded tympanic membrane.

wait until these frogs are in their third year before attempting to breed them. This will ensure they have developed sufficient fat stores to undergo the required cooling period safely. Adult males are typically slightly smaller than females, and will develop characteristic darkened areas on the insides of their thumbs. These so-called 'nuptial pads' are used to grip onto the female when they are in their mating embrace, known as amplexus.

This species is one of the easiest pet tree frogs to breed successfully, and you can stimulate adults to reproduce naturally in the terrarium by replicating the seasonal environmental changes they would experience in the wild. Natural spawning is most easily achieved by first withholding the frogs' daily feeds for five days prior to cooling, in order to allow their digestive tracts to empty, and then gradually reducing the terrarium temperature to around 20°C (68°F) during the day, dropping back slightly to 19°C (66°F) at night.

These temperatures should be maintained for a period of four weeks,



▼ A young bluish White's tree frog. Colouration in this species is quite variable.



Great care should be taken not to overfeed White's, which are one of nature's gluttons. They will happily gobble up more food than is good for them given the chance, resulting in one of the most significant health problems associated with this species – obesity.

during which the UV lighting is turned off completely, with only a low wattage 'night-time' (red or purple coloured glass) bulb being used to heat the vivarium. Most White's will leave their arboreal perches and basking spots and will rest on the terrarium floor at this stage, and so should be provided with cork bark hides and sphagnum moss 'beds' here. They should not be fed at all, although a clean water source will still be needed to prevent them from dehydrating, and you must keep a careful watch over the frogs to ensure they are not becoming unduly thin.

Once the cooling period is complete, the ambient temperature range can be slowly increased back to normal over a period of a week, and the usual UV photoperiod restored. When the frogs have started to become active again, they should be offered regular and generous meals of various gut-loaded livefoods. Additional waxworms and even the occasional pinky mouse are ideal for conditioning purposes, to encourage spawning.

Spawning

During this time, an egg-laying pool should be introduced to the terrarium. This can be in the form of a large tray or plastic storage tub filled to a depth of 7.5cm (3in) with rainwater. It needs to be heated to 29°C (84°F) using a small thermostatically-controlled aquarium heater, shielded with a special mesh cover so it cannot burn the frogs. Alternatively, a heat pad can also be used outside the tank for this purpose, again regulated by a thermostat.

There should also be a rock or branch that the frogs can use as an island to sit on and climb easily in and out of the pool. After 1-2 weeks, a regime of misting the enclosure four times daily for several minutes at a time in order to soak the frog's surroundings thoroughly with tepid water should stimulate the males to begin calling, and pairs should be seen in amplexus shortly afterwards.

Another method favoured by some keepers involves using an artificial rain chamber to stimulate these tree frogs to spawn. The adults are prepared for breeding using the same cooling method described above, and then moved into a separate, purpose-designed terrarium which will act as a rain chamber once they have been warmed up again. A rain chamber can



▲ A male calling as a prelude to spawning.



▲ White's tree frogs will become inactive when they are being conditioned to breed.

be constructed from a glass terrarium or aquarium, complete with UV lighting and being filled to a similar depth with heated water as described above, again including several land areas created from rocks or sections of bog wood.

The rain system itself is made from an external aquarium filter pump that draws water from the bottom of the tank and circulates it through a length of 2.5cm (1in) PVC or aquarium airline piping fitted to the chamber's ceiling that is perforated with small holes every 2cm (0.75in) along its length. As the water is pumped along the tube, it escapes in droplets from the holes and creates a rain-like effect inside the chamber, which is controlled by an electronic timer to activate the system to rain for 4-5 hours each evening.

This method tends to work very well for stimulating White's to reproduce, being especially useful for encouraging pairs that are reluctant to breed using the natural terrarium method.

Females lay their 800-1500 eggs with their back ends submerged in the water, and the male uses his back legs to spread his sperm over them as they are laid.

Rearing

The eggs then sink to the bottom in a clump with the fertilised embryos

appearing as black spheres inside a clear layer of protective jelly, with hatching taking just 24-48 hours. Once all the tadpoles have emerged, they should be gently removed from the water using a spoon or fine fish net, and placed in a rearing tank.

This should be a large aquarium or sturdy tub lit with a full spectrum UV tube for 12 hours a day, heated to 30°C (86°F), furnished with clean gravel and live aquatic plants, and filled with natural rain water. Water from a garden pond can also be used provided the keeper is absolutely certain that it is unpolluted, as it does carry the advantages of already being stocked with beneficial microflora, essential minerals, and tiny vertebrates for the tadpoles to feed on.

The tadpoles can be reared on a variety of live aquatic foods such as daphnia, banana worms and micro worms, as well as small amounts of crushed fish flake food, and they should metamorphose into small froglets in about a month. There are also now tadpole foods available from specialist suppliers. Regular partial water changes are also essential.

Juvenile White's tree frogs can be maintained in small plastic terrariums with mesh tops, furnished with plastic leaves, sphagnum moss and a Petri dish of water at first. Once they are around 2.5cm (1in) in length, they can then be moved into an adult-sized terrarium. ❖

Herpetological Mysteries

A CLOSE ENCOUNTER OF THE MEGA-ARACHNID KIND!

EXCLUSIVE

Here in the first of a two part mini-series, Dr Karl Shuker investigates the possibility of the existence of gigantic spiders, living in the US state of Louisiana, with this information being published for the first time in these articles.



Exclusive sign courtesy Gembuls/www.shutterstock.com & giant spider courtesy Warpaint/www.shutterstock.com

Of all of the countless cryptozoological subjects that I have researched and written about over the course of the past three decades, few have attracted more interest and correspondence than reputed sightings of giant spiders. It has been claimed that some of these huge arachnids have been the size of puppies, or even small children! Although these reports have come from a variety of far-flung locations around the world, the vast majority of them have originated, not unsurprisingly, from remote jungle locations within parts of tropical Africa, South America, Asia, and New Guinea.

► Louisiana lies in the southern part of the USA, adjoining the Gulf of Mexico, with Texas on its western side.
Map courtesy Bardocz Peter/
www.shutterstock.com



An unlikely location

However, among them have been two very intriguing (and frightening) reports of a huge spider allegedly encountered in suburbia: one from England, and one in the USA. Partly because of these particular locations - let alone the various anatomical and physiological restrictions that would seem, at least theoretically, to prevent any modern-day spider species anywhere from attaining the kind of size attributed to the alleged specimens - I considered these two specific examples to be among the least likely of all such reports.

However, now I may have to think again, because I recently received a series of very detailed and truly extraordinary communications from a soldier in the United States. He claims to have been one of several army personnel who encountered these enormous spiders at close quarters while conducting field training in Louisiana.

The soldier (whose name I have on file, although he has asked me not to identify him) had been troubled by his experiences with these creatures for some years, but knowing of my interest and work relating to mystery creatures, he finally decided last year to reveal his full, incredible story to me, via a series of emails.

Moreover, he also gave me full permission to document them publicly, in the hope that others would learn about these creatures



▲ The observations that were reported came from a US soldier when he was stationed at Fort Polk. Photo courtesy WanderinNomadPhotography/www.shutterstock.com

and that one may even be obtained for scientific study and identification. Needless to say, as I have no independent corroboration (yet?) for any of the details given to me by him, I am unable to confirm whether or not any of what follows is genuine, but I consider it more than sufficiently compelling to warrant documentation.

So here, in a world exclusive for PRK, and described in his very own words, is the truly fascinating, frightening and hitherto-

unpublished saga of that soldier, whom I shall refer to hereafter simply as Sgt S - although this is not his real rank or initial). It consists of three separate alleged encounters with some truly monstrous spiders in the southern US state of Louisiana. Arachnophobes, you have been warned!

Initial contact

I received Sgt S's first email on 25 July 2019. It was quite brief, merely asking me if I would be interested in



Members of the theraphosid group, which represent the largest spiders known to science, have a formidable appearance, although they grow no larger than a dinner plate, with their legs are extended. They would be dwarfed by this reported new spider from Louisiana, assuming it exists.

Photo courtesy D. Kucharski K. Kucharska/www.shutterstock.com



hearing his first-hand accounts of:

"...three separate incidents where I witnessed giant spiders at Fort Polk, Louisiana, in 2005 and 2007. These incidents took place at US Army training areas twice at night and once in the day."

Naturally, I swiftly replied, stating that I would indeed be interested in doing so, and the very next day I received an email from Sgt S containing the following extensive report:

"Below is my detailed account from 2005. I will send more information on the 2007 sightings later. Recalling this matter was difficult and stressful, but I needed to get it off my chest as the events have haunted me for over a decade. I reached out to you in hopes that this helps your research and may someday lead to enlightening the world to the existence of these creatures. In the meantime, I prefer to remain anonymous but give you full rights to use my story."

"In 2005, I was a US Army soldier stationed at Fort Campbell, KY with D Company, 1st Battalion - 101st

▲ A spider in close-up, revealing a pattern of 'eyes' very similar to that described by Sgt S. Photo courtesy Protasov AN/ www.shutterstock.com

Aviation. Sometime in early 2005, 101st Airborne Division traveled to Fort Polk, Louisiana's Joint Readiness Training Center for several weeks of complex field training.

"In the early evening, I was asked to escort a female soldier (for her privacy I'll call her Sergeant Becky) from our Company tents to our motor pool, walking on a dirt road between two wooded areas, both of us holding flashlights. She was roughly 5 paces (10-15 feet) in front of me when she tripped, stumbled down and started screaming in high pitched shrieks.

The first sighting

"As I ran up checking on her, I saw a large "hairy thing" about four feet (=1.2m) away from her, on the woodline at the right side of the road. At the time I was not wearing my glasses and being near-sighted, it was mostly blurry until I closed the distance next to Sgt Becky, where I froze in place about five feet (=1.5m) from the "hairy thing".

"As I focused on it for a few seconds, I could see the creature had whitish-

gray or beige bristles all over it, in mottled color variations. The head was rectangular shaped with curved corners and small bumps trailing down into ridges along the sides. The creature had two large black eyes about two inches (=5cm) around and several smaller black eyes or spots on its head.

"At first approach, its head was about three feet (=0.9m) from the ground with two long, thin legs raised up in front reaching five feet (=1.5m) up in the air, with several long, thin, stick-like legs supporting behind it, each about one inch (=2.5cm) around. As I was running up, I unknowingly kicked rocks and dirt right at the thing, and it reacted by instantaneously backing up and pulling its head and legs down and back to about two feet (=0.6m) from the ground and balled-up roughly two feet round (=0.6m).

"I could see it perfectly still for a second while I froze in place. Then it popped its head up briskly to three feet (=0.9m) again and splayed its legs out to about four or five feet (=1.2-

1.5m) wide and opened its mouth like it was going to pounce. The mouth hole was about two or three inches (=5-7.5cm) while the fangs were about four to five inches (=10-12.5cm), ruddy reddish-brown colored, with fuzzy bristles all over the mouth.

"Both Sergeant Becky and I fired our M4 carbines at it (we only had blank rounds for training). With the flash and noise, it scurried back into the trees and was gone in a split second. Sergeant Becky was still screaming, trying to crawl away and was stuck on something on the ground that looked like a rope. I stepped on it too and it was stuck to my boot and I had to cut her loose with my knife. We were both uninjured, save for Sergeant Becky being severely traumatized by the incident, requiring her removal from training and commander's referral to Mental Health.

Signs of a spider

"Later when our senior leadership inspected the area we found long sticky spider web-like strings leading to a half-meter (=19.7in) hole that was thatched over with leaves. The same material was stuck to our boots and my knife which I could only clean off with a cigarette lighter. The military refused to believe us and insisted that we only saw a wild dog suffering from mange.

"The Sergeant was referred to Mental Health on a long term basis

Photo courtesy Photo_S5/www.shutterstock.com



▲ In spite of finding obvious signs of a spider, the military commanders stated that it must have been a dog with mange that the pair encountered, although there seems very little similarity between the two.

Follow-up

After receiving an email of thanks from me for his account, and also containing a few lines of discussion concerning size-related respiratory restrictions applicable to spiders,

▲ Soldiers on an exercise in the woods at Fort Polk, Louisiana, where the encounters occurred. Photo courtesy WanderinNomadPhotography/www.shutterstock.com

and we were both ridiculed and ordered not to talk about it anymore. I was called into the Mental Health facility on return to Fort Campbell to corroborate Sergeant Becky's story and subsequent stress issues. Our leadership at the time 'actively discouraged' me from offering any details other than that I saw 'a hairy thing about the size of a dog'. I have not talked about it with anyone since."

sent later that same day, which was 26 July, I received a short follow-up email from Sgt S as follows, which referred to a previous sighting:

"Thank you for getting back so quickly. I appreciate your interest. It takes time to go through and detail what I saw but I'll work on the other two sightings this weekend. The locations I am reporting at Fort Polk are only seven miles (=11.2km) away from Highway 171 in Leesville, Louisiana where the 1948 report occurred. It is important to note that the military training personnel at Fort Polk often joke about the insects that are big enough to carry people off. Also, they mention that people tend to go missing there so they caution staying in groups, especially at night. It might be worthwhile to delve into missing person reports."

Sgt S's next email to me was sent by him on 29 July, and contained not only a detailed account of his two 2007 sightings but also some noteworthy additional details regarding his 2005 sighting, as well as his personal thoughts concerning the lifestyle of these spiders. Here are the extra details that he supplied relating to his 2005 sighting, in his own words:

"I have compiled an addendum of additional observations from the 2005 sighting. After writing the incidents



▲ After the encounter, the soldier's companion was referred for long-term mental health treatment.

Photo courtesy WanderinNomadPhotography/www.shutterstock.com



▲ Fort Polk lies to the south of Leesville.

Map courtesy SevenMaps/www.shutterstock.com

down I began to recall other related details surrounding these incidents. You have my full permission to publish this story so long as my name is kept anonymous until one of these things is captured or killed for positive scientific identification.

"On the same night of [the] 2005 incident, while our senior leadership was reviewing the spider hole area, we found a circular thatched cover about half a meter (=1.6m) wide, hinged to the back of the hole with some type of glue. It was woven from small sticks and leaves "glued" together with an unknown substance, with a symmetrical, radial patterning. It was sturdy and lightweight. There was also a very strong, acrid / ammonia-like scent at the site which persisted on our clothes for several days.

A soldier goes missing

"An Opposition Force Sniper disappeared the next night not far from the original incident. I was inside the back of a truck pulling guard duty at the flight line perimeter fence, near a heavily wooded area when I caught an opposition force soldier (for privacy I'll call him SGT SAM) sneaking up on our position. I tackled SGT SAM and held him in place while his teammate was firing at our position from inside the wood line.

"We heard sounds from the wood line of someone crying out and then abruptly silenced followed by snapping branches and then something moving in the brush. After the training cadre cleared and reset our position, SGT SAM went back to check on his teammate who was not answering radio calls and he could not find [him]. SGT SAM came back insisting that something was wrong.

"The next morning SGT SAM and his teammates lead a search for the missing soldier finding only a torn

► Spider webs trailing over the ground. They are often sticky by nature and strong. Web-like structures and retreats were recorded in association with the Fort Polk sightings. Photo courtesy Trial/www.shutterstock.com



▲ Could an unknown species of giant spider be responsible for the soldier's disappearance? There is a report of a number of these spiders being observed together. Artwork courtesy Wapaint/www.shutterstock.com

▼ A soldier reportedly disappeared unexpectedly on a night-time training mission in the woods. Photo courtesy PRESSLAB/www.shutterstock.com

piece of his shemagh scarf in the woods near our position, which he said he would never tear apart, let alone leave anything behind as he was meticulous about his job and his equipment. The sniper's disappearance during a training exercise, lack of response to radio calls and absence from rally points all being highly unusual and disturbing to his teammates. Army investigators were oddly aloof and unconcerned citing that many good soldiers go AWOL to New Orleans.

A wider involvement

"A few days afterward, and very late at night, several soldiers and I heard something walking across the tin roof of our double-barn sized sleeping quarters. It sounded like slow heavy raindrops for one minute and then stopped abruptly. There was no rain at the time and when we went outside to look there was nothing on the roof.

"Another night a soldier claimed he awoke to what he thought was an old bearded man with huge black goggles lying prone on the ground at the doorstep staring at us through the open door of the tent. He said the man crawled back quickly and was gone over a ten-foot (= 3m) fence and back into the woods in seconds when he sat up to question him.

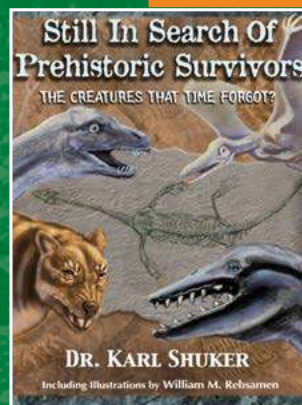
"A rumor circulated from the local post soldiers that a Wildlife Management Ranger in a tree-mounted deer blind had observed eight of these creatures gathered in a remote clearing, facing each other in a circle, taking turns placing sticks into a pile. I find this highly dubious and probably a fable to scare visitors, but

it does show that the locals already have an awareness of these things and openly joke about them."

NEXT MONTH: In the concluding part of this article, Karl publishes the remainder of this fascinating email for the first time. It contains Sgt S's even closer alleged encounters of the arachnid kind from 2007, together with Karl own zoological interpretations regarding these mega-spiders' possible existence and lifestyle. Don't miss it!

* Dr Karl Shuker BSc PhD FRES FZS is a zoologist, author and broadcaster who is pre-eminent in the field of cryptozoology – the study of animals whose existence is not proven.

Karl's new book



Karl's latest book *Still In Search Of Prehistoric Survivors*, is now available from high street and online booksellers, priced from £37.95. It extends to over 600 pages, and is 260,000 words long.



METAMORPHOSIS

Can you identify the five reptiles listed here, and then using the first letter of each of their common names, arrange these to give the name of another creature entirely?



PHOTO COURTESY CSAKANYL/WWW.SHUTTERSTOCK.COM



PHOTO COURTESY MATT JEPSON/WWW.SHUTTERSTOCK.COM

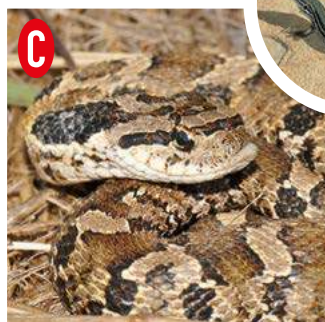


PHOTO COURTESY MATT JEPSON/WWW.SHUTTERSTOCK.COM



PHOTO COURTESY RUSTY DODSON/WWW.SHUTTERSTOCK.COM

Puzzle Corner

Find the solutions to these puzzles by following the clues, to discover which reptiles, amphibians or invertebrates are hidden within them. The answers can be found on p66.

CREATURE SWAP

Can you identify the following reptiles and amphibians, and then, by using and re-ordering the first letter of each, come up with the name of a totally different creature?



PHOTO COURTESY ENRIQUE RAMOS/WWW.SHUTTERSTOCK.COM



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YOU & YOUR Reptiles



If you have a favourite photograph of one of your reptiles, amphibians or invertebrates which you'd like to see included in the magazine, then email practicalreptilekeeping@gmail.com. Please include details about the subject, confirm anyone in the picture is happy for it to be published and that you took it. Here are some samples to show the type of photos that we're looking for! Next month, the winner will receive an Earth-Pro Jelly Pot Gold kit, courtesy of Arcadia Reptile, worth £14.99. This will enable you to make up your own jellypots as you require them. These are very easy to prepare. You just measure out the powder with the measuring spoon, then mix it with hot water and wait for the jelly to set in the reusable pots. The ingredients contain no artificial colours or flavours, but very high quantities of whole fruits, honey, bee pollen, insects and plant matter. There are five different choices in the range, each with their own unique recipe, and you can buy replacements easily, making this system very cost-effective.

WIN



Joey, the crested gecko at two months of age.
From Gwydion in Cwmbran, South Wales.



Agi from Bedford sent this photo of Choco, the western hognose.



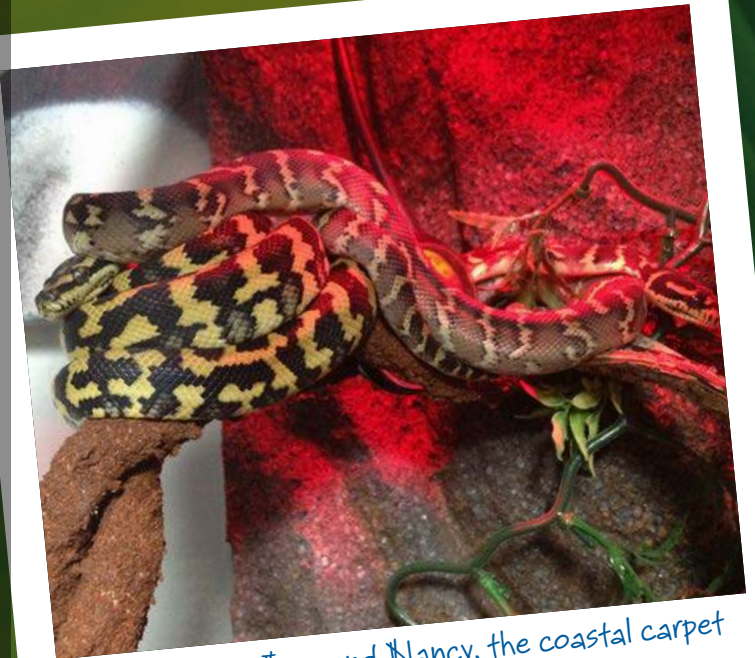
Bearded dragons Rocky and Rosie. From Vicky in Dudley.



New pygmy chameleon joins the San Sior school's collection in Llandudno.



Ozzy the bearded dragon. From Laura in Kent.



Sid the Iranian Jaya and Nancy, the coastal carpet python. From Rhys in Leeds.



Toothless the bearded dragon. From Bruce.



Rusty, my greenbottle blue tarantula. From Nikki in Glasgow.



Squishy, a crested gecko bred by Bruce from Sheffield.



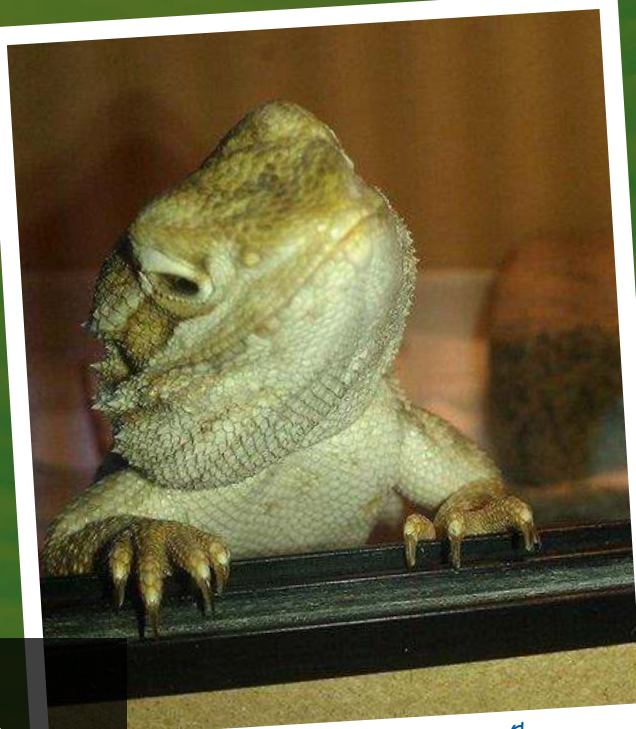
Elmo, a green tree python, from Gemma in Cumbria.



Three little viper geckos - Jupiter, Neptune and Saturn. From Michelle in Rushden, Northamptonshire.



▲ Charlie in Salisbury sent this photo of Magnus the crested gecko.



Elmo, a green tree python, from Gemma in Cumbria.

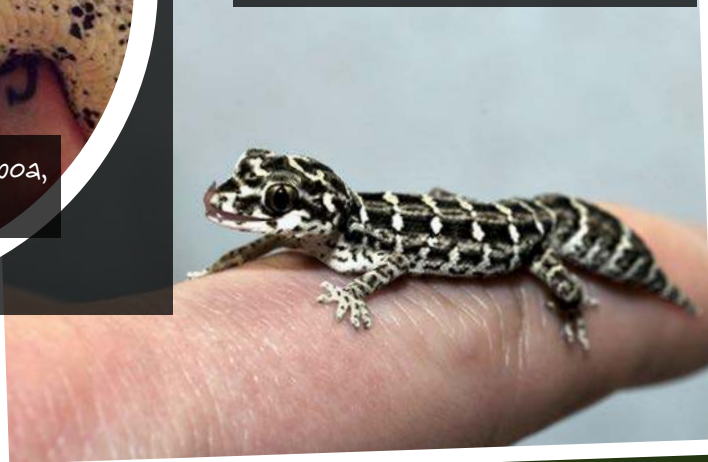


Harley, the female common boa, kept by Paul in Jarrow.

Grizzy the bearded dragon. From Kirsteen in Kilbirnie, Ayrshire in Scotland.



One of Andy's young viper geckos.



Spanner the Boscs monitor enjoying the sunshine. From Sharyn in Ipswich.



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Issue 122

.Next issue.

NEW THOUGHTS ON LEOPARD GECKOS

John Courteney-Smith MRSB looks at recent advances in our knowledge and understanding of this very popular species.

Photo courtesy Reinhold Leitner/www.shutterstock.com



In the **Practical Reptile Keeping** issue 124

THE HUGE SPIDER FROM LOUISIANA



ENTERING THE WORLD OF SPOTTED NEWTS



These stunningly beautiful amphibians from parts of western Asia are now being seen with increasing frequency, as they are spawning more frequently in vivarium surroundings. Discover what is involved in their care, and why captive-breeding could be so vital for their future survival.

**PLUS ALL OF
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including Q&A, News and Views, Out of Africa, Herpetological Mysteries, You & Your Reptiles.

*These are just some of the features planned for the next issue but circumstances outside our control may force last-minute changes. If this happens, we will substitute items of equal or greater interest.

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CREATURE SWAP SOLUTION:

- 1 ORIENTAL FIRE-BELLIED TOAD (*BOMBINA ORIENTALIS*)
- 2 RHINOCEROS IGUANA (*CYCLURA CORNUTA*)
- 3 EUROPEAN POND TURTLE (*EMYS ORBICULARIS*)
- 4 SPOTTED SALAMANDER (*AMBYSTOMA MACULATUM*)
- 5 HORSFIELD'S TORTOISE (*AGRIONEMYS HORSFIELDII*)

REARRANGING THE FIRST LETTERS OF EACH NAME THEN GIVES THE SOLUTION, WHICH IS HORSE.

METAMORPHOSIS SOLUTION:

- 1 Grass snake (*Natrix natrix*)
- 2 Rubber boa (*Charina bottae*)
- 3 Eastern hognose (*Heterodon nasicus*)
- 4 Texas banded gecko (*Coleonyx brevis*)
- 5 Iberian wall lizard (*Podarcis pityusensis*)

Reordering these letters then gives the answer to the puzzle - TIGER

Practical Reptile Keeping and the Pet Advertising Advisory Group recommend that if you decide to buy a reptile or amphibian, you should:-

* **RESEARCH BEFORE YOU BUY.** Be sure you fully understand and appreciate the needs of the reptile or amphibian you are interested in, and that you can provide a suitable environment.

* **SEEK ADVICE FROM BOOKS,** the internet and your local veterinary practice who may also be able to recommend a suitable expert for additional advice.

* **ENSURE YOU KNOW** what facilities are necessary to provide a suitable environment for the animal – e.g., vivarium, temperature, humidity, light quality etc..

* **ENSURE YOU BUY** from someone who specialises in the animal you are interested in.

* **VISIT THE ANIMAL** you are intending to buy.

* **CHECK THAT THE ANIMAL'S** accommodation is clean, it is supplied with the appropriate food and water, and that special equipment for maintaining the animal's environment (e.g., heat lamps or UV lights, etc) is working properly.

* **ENSURE THAT ALL RELEVANT PAPERWORK IS AVAILABLE FOR INSPECTION WHEN YOU VISIT.** This could include any necessary

permits such as CITES registration documents, Dangerous Wild Animals Licence or other documentation.

* **IF ANY PAPERWORK IS UNAVAILABLE** and has to be sent on, obtain a written commitment as to when it will be delivered.

* **ENSURE THAT THE ANIMAL YOU ARE BUYING** is healthy and free from signs of injury or disease.

* **REMEMBER THAT SOME REPTILES CAN GROW VERY LARGE** and some species can live for 50 years or more. Veterinary care can be very expensive.

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INFORMATION AND INSIGHT!

TALES FROM THE REPTILE HOUSE

by **Practical Reptile Keeping** columnist **Bill Lowe**

Reptiles and amphibians have fascinated Bill Lowe since childhood, and there was just one job that he really wanted: to be able to work with and study them. He readily gave up an apprenticeship at a whisky distillery to achieve this goal, going on to become curator of a zoological collection in Scotland, and here you can discover just what happened.

These memoirs, written with gentle humour and great insight, will appeal to everyone who likes animals, and especially those with a herpetological interest. Bill also takes the opportunity to pass on a host of practical care tips, based on his first-hand experiences with this group of animals.



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