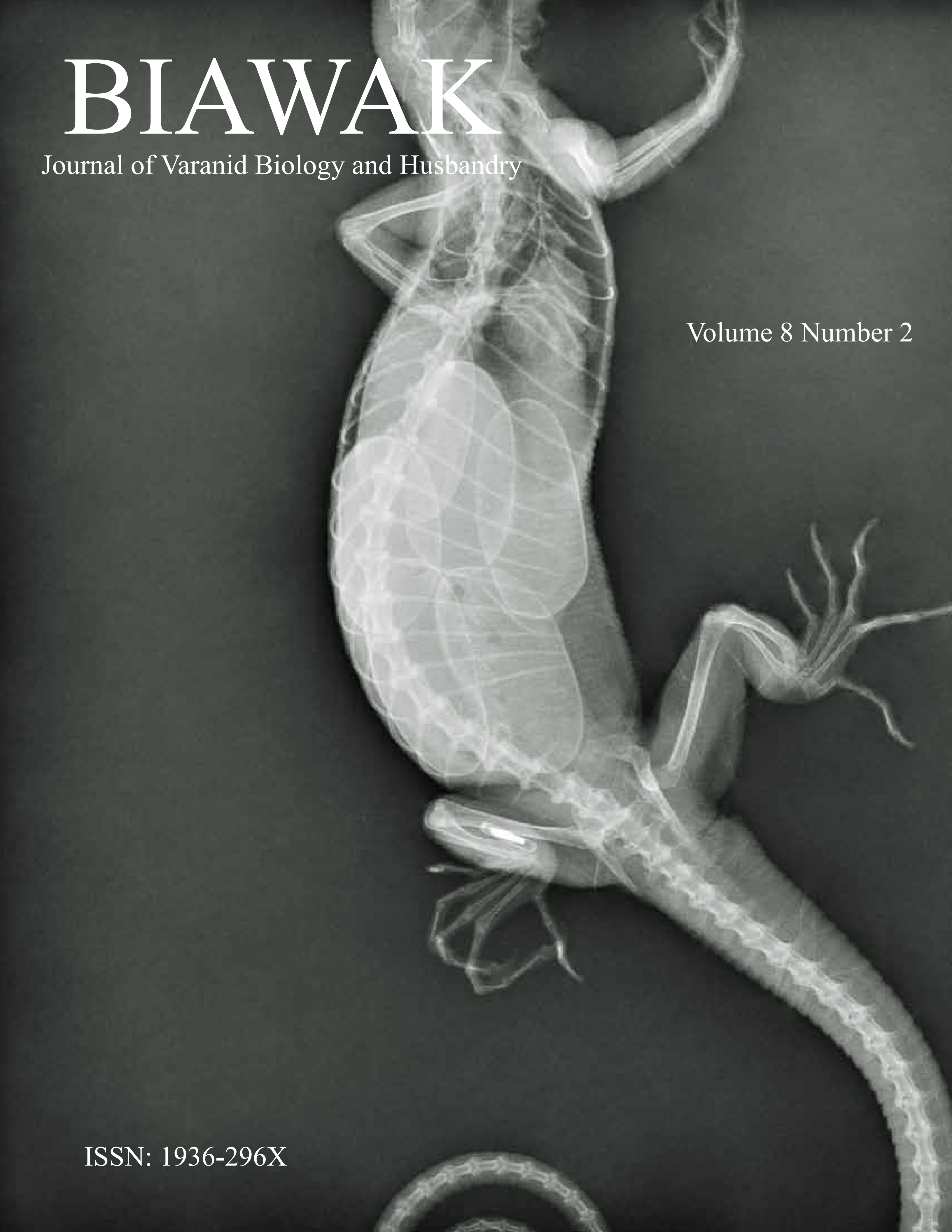
BIAWAK

Journal of Varanid Biology and Husbandry

Volume 8 Number 2



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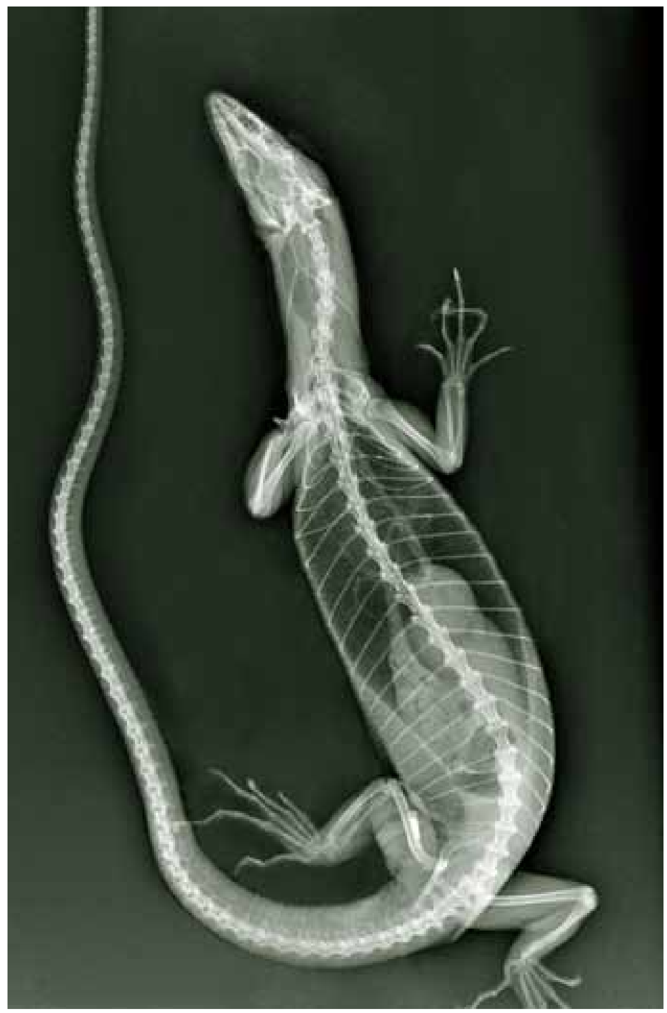
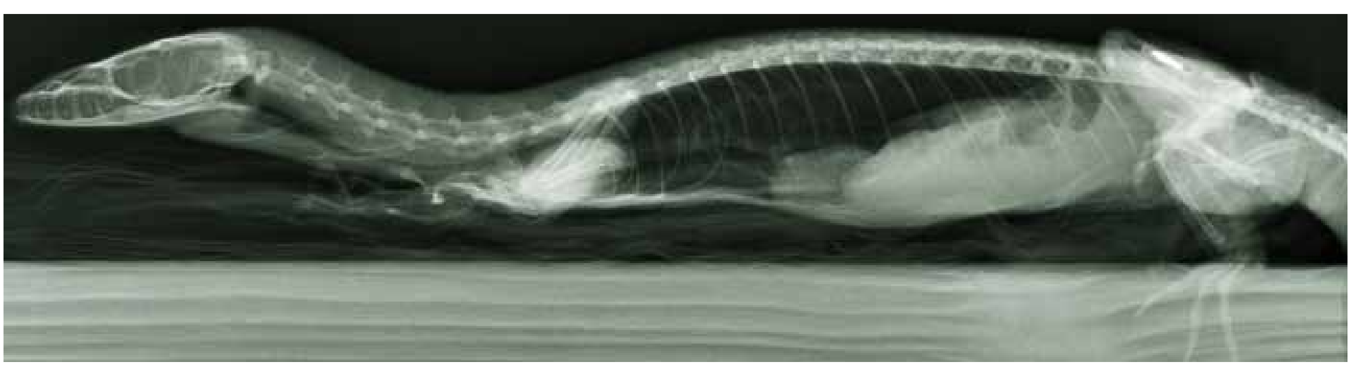
On the Cover: *Varanus prasinus*

The *Varanus prasinus* depicted on the cover and inset of this issue is a captive-bred female currently residing at Bristol Zoo Gardens (UK). Hatched in 2007, this female was radiographed in 2013 by the zoo's veterinary department during a health screening due to concerns that it was experiencing reproductive complications (cover & left). Although clearly gravid, as evidenced by the six eggs visible in the radiograph, the female made no attempt at nesting and gestation was well past 40 days since the first observed copulation. No signs of blockage were obvious, and the female ended up scattering the eggs throughout the enclosure over the next couple of days. As only five eggs were found, a follow-up radiograph was performed to determine if the sixth egg had been retained (right & bottom), which it had not. It was presumed to have been eaten by the female, and the egg's casing was later found in the female's feces. None of the eggs proved to be viable. Contributed by **Adam C. Davis**.





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Journal of Varanid Biology and Husbandry

INTERNATIONAL VARANID INTEREST GROUP
www.varanidae.org

The International Varanid Interest Group is a volunteer-based organization established to advance varanid research, conservation, and husbandry, and to promote scientific literacy among varanid enthusiasts. Membership to the IVIG is free, and open to anyone with an interest in monitor lizards and the advancement of varanid research. Membership includes subscription to *Biawak*, an international research journal of varanid biology and husbandry, and is available online through the IVIG website.

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Varanus flavescens. Keranigonj, Dhaka, Bangladesh. Photographed by **Abu Bakar Siddik**.

NEWS NOTES

Man Jailed After Killing Monitor Lizard

An Indian man has been sentenced to six months imprisonment for killing a monitor lizard (most likely *Varanus bengalensis*) and possessing two additional specimens in Virdi, Sakhali. The man was found guilty for hunting the species, which is protected under the Wildlife Protection Act of 1972.

Source: http://timesofindia.com; 2 May 2014

Brevard Zoo Monitor Lizard Dies

An 11 year old black-throated monitor, *Varanus albigularis*, died at the Brevard Zoo (USA) following a recent surgery to treat a condition that had been affecting the animal's use of its rear legs. Previous efforts to treat the condition had included radiographs, ultrasound, bloodwork, physical therapy, hyperbaric treatment, and cold laser therapy. A pathological analysis will be performed to determine a cause for the animal's death.

Source: http://floridatoday.com; 9 June 2014

Varanus salvator Captured on Oahu, Hawaii

A juvenile Asian water monitor (*Varanus salvator*) measuring approximately 46 cm in total length was captured at Joint Base Pearl Harbor-Hickam on the island of Oahu, Hawaii on 27 June 2014. The lizard was first spotted in a maintenance shop near the base's airfield, and was eventually captured the following

Varanus hamersleyensis. Karijini National Park, WA. Photographed by **Chris Nelson**.

day by Hawaii Air National Guard personnel. Officials suspect that the lizard was accidentally transported from Malaysia with a recent shipment of equipment to the base.

Source: http://khon2.com; 30 June 2014

Komodo Dragon Dies at Surabaya Zoo

An 11 year old Komodo dragon (*Varanus komodoensis*) died at the Surabaya Zoo in August 2014. An initial necropsy indicated that the death of this animal, the third *V. komodoensis* to die at the zoo in 2014, was related to intestinal problems. Seven male, six female, and 59 juvenile *V. komodoensis* currently reside at the zoo, and more than 30 eggs are reported to have been laid since July. Surabaya Zoo has been criticized in recent years due to a number of high profile animal deaths and animal welfare concerns.

Source: http://news.discovery.com; 7 August 2014

Komodo Dragon Receives Acupuncture

A 20 year old Komodo dragon (*Varanus komodoensis*) residing at the San Antonio Zoo (USA) has received acupuncture therapy to alleviate the effects of degenerative bone loss in the animal's knee joints. The animal has recently experienced difficulty moving as a result of this condition, and while treatment for the condition itself is not available, acupuncture and traditional medicine are hoped to help ease the dragon's movements.

Source: mysanantonio.com; 4 September 2014

Stuffed Toy Surgically Removed from Monitor Lizard

A two year old *Varanus exanthematicus* was rushed to a veterinarian after it had swallowed a stuffed animal toy, mistaking it for a mouse. The lizard seized the toy as it

Varanus bengalensis. Parasan VDC, Kanchanpur District, Nepal. Photographed by **Hemant Raj Ghimire.**

was being played with by the owner's dog, swallowing it whole. Unable to be passed naturally, surgical intervention was needed for its retrieval.

Source: http://dailymail.co.uk; 19 September 2014

Infant Injured by Monitor Lizard

An 8 month-old infant was bitten on the face and seriously injured by a large water monitor (*Varanus salvator*) in the Malaysian village of Kampung Tekek on Pulau Tioman. The incident took place in a home where the infant had been lying on a kitchen floor. According to the mother, she heard a loud noise and returned to see the monitor attacking the infant's head and attempting to carry it into the bushes. The lizard was driven off and the infant taken to a hospital, where she was reported to be in stable condition.

Source: The Rakyat Post; 23 September 2014

Cull of Water Monitors on Tioman Island

A cull of water monitors (*Varanus salvator*) has been planned in Kampung Tekek on Pulau Tioman, Malaysia. Officials claim the population has increased to excessive levels and will attempt to reduce it by 10-15%. Locals have reported more incidents of the animals clashing with villagers including the recent attack on an infant, though it was not mentioned whether that incident was an impetus for the cull. Officials will also be instructing locals on waste disposal in an attempt to lessen the number of lizards attracted to human dwellings.

Source: Daily Express; 28 September 2014

Varanus bengalensis Find New Home at Vandalur Zoo

Forestry officials of Pudukottai District recently rescued a large group of Bengal monitors (*Varanus bengalensis*)

Varanus baritji. Batchelor, NT. Photographed by **Jasmine Vink**.

from a tribal settlement in Arathangi, India, where the lizards were being sold illegally for their meat. Twenty three of the rescued *V. bengalensis* were transported to the Vandalur Zoo where 16 of them will be housed in an enclosure currently housing Asian water monitors (*V. salvator*). Once their physical conditions improve, they will likely be released into Guindy National Park.

Source: http://thehindu.com; 19 October 2014

Cameron Park Zoo Hatches Komodo Dragons

The Cameron Park Zoo (USA) recently announced the successful hatching of two Komodo dragons (*Varanus komodoensis*). Zoo officials suspect that the hatchlings are the result of parthenogenesis as the female, named Neoma, has not had known contact with the resident male. However, they have not ruled out the possibility that one of the animals climbed a mesh barrier separating them and will be conducting DNA tests to confirm this. The male, named Thurber, was himself a result of parthenogenesis; the first case observed in the United States which occurred at the Sedgewick Country Zoo in 2008. The two hatchlings are now on public display.

Source: http://kcentv.com; 14 November 2014

Grand Rapids Komodo Dragon Dies

The John Ball Zoo in Grand Rapids, Michigan (USA) has announced that their Komodo dragon (*Varanus komodoensis*), a 22 year old male named Precious, has died. Officials did not provide a cause of death but stated "natural causes". Precious was part of the first clutch of dragons produced outside of Indonesia, a group of thirteen hatched at the National Zoo in 1992.

Source: http://wzzm-13.com; 3 December 2014

Varanus giganteus. Alice Springs, NT. Photographed by **Darren Schiller.**

IUCN Monitor Lizard Specialist Group Established

Although monitor lizards represent a rather small group of squamate reptiles, many of the 75 currently recognized species are affected by habitat destruction and are heavily exploited by the commercial skin and pet trades (e.g., Koch *et al*. 2013. Herp. Cons. Biol., 8, Monograph 3:1-62). Of particular concern are those species which possess restricted distribution ranges. For species such as the members of the New Guinean tree monitor lizards, or *Varanus prasinus* species complex, their attractive appearance has fueled desirability and value within the pet industry, which raises concerns that commercial exploitation might have a detrimental effect on overall populations and possibly lead to extinction.

Despite their popularity and exploitation, the size and status of populations for the majority of monitor lizard species remain unassessed. Notably, for at least two thirds of all species, a critical evaluation of their potential vulnerability is lacking.

With the aim of ensuring the long-term survival of all monitor lizard species and their continued role as apex squamate predators in the various ecosystems they inhabit, the Monitor Lizard Specialist Group (MLSG) was founded in September 2014 as part of the Species Survival Commission of the IUCN (International Union for Conservation of Nature, www.iucn.org), the world's largest and oldest organization for nature conservation. At present, the MLSG has 40 members from Africa, Asia, Australia, Europe and the US.

The overarching goal of this Specialist Group is to assess current threats and the conservation status of all monitor lizard species, and update the status of those few that have already been assessed. In addition, the rare and elusive Bornean earless monitor lizard (*Lanthanotus borneensis*) has been included in the scope of the MLSG. These critical assessments will be conducted in the framework of Red List Assessments and will serve as basic conservation data for national science and management authorities, as well as inform CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora, www.cites.org), which regulates and monitors the international trade of all varanids (and products made from them). Information regarding current population trends and conservation issues will be shared with other interest groups.

Accordingly, based on these Red List assessments characterizing the conservation status of all monitor lizard species, specific conservation-oriented research projects will be required to fill current knowledge gaps in order to enable assessments of species for which adequate data are lacking. The first inaugural meeting of the new IUCN expert panel is scheduled for 23-24 July 2015 in Bangkok, Thailand, in association with the planned international monitor lizard conference (see announcement by Michael Cota in this issue of *Biawak* for details of the conference).

Further voluntary experts are invited to join this dedicated group of scientists, conservationists, zoo associates and private herpetoculturists. Assistance is also needed to create a logo and website for the MLSG and to attract funding for future projects.

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Interdisciplinary World Conference on Monitor Lizards 27-29 July 2015

at the Phranakhon Rajabhat University
Hosted by the Faculty of Science
Phranakhon Rajabhat University
Bangkhen District, Bangkok Thailand

The interdisciplinary World Conference on Monitor Lizards will focus on the biology, ecology, natural history, and captive breeding of monitor lizards. Manuscripts and posters will be accepted starting in February 2015 and are to be submitted to: monitor.conference.2015@gmail.com

Optional Events Scheduled for 24, 26, 30-31 July 2015

24 July 2015	Day Trip to the Natural History Museum and National Science Museum, Thailand.
26 July 2015	Day Trip to Dusit Zoo to see Bangkok's largest wild urban population of *Varanus salvator macromaculatus.*
30-31 July 2015	2 day trip to Khao Yai National Park.

Conference Fee: Has not yet been determined, but will be cheaper than comparable international conferences. We are tentatively planning for a conference fee of $200USD. Included with the conference fee is conference attendance, lunch along with coffee breaks on the days of the conference and the welcome dinner on the first day of the conference. Also included with the conference fee is a copy of the conference proceedings to be published after the completion of the conference.

Optional events are extra and are not included in the conference price. The price for these events is still being worked out at this time.

Conference registration, submission of manuscripts and further inquiries can be sent to Michael Cota at monitor.conference.2015@gmail.com. The amount of time per presentation given to participants will be dependent on the number of total presentations to be given. Special considerations for specific time allocation requests will be made on a case by case basis.

Those interested are encouraged to send an email, so they can be informed of any new information as it becomes available regarding the conference and optional events.

ARTICLES

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A Novel Underwater Foraging Behavior Observed in *Varanus prasinus* at the Wildlife Conservation Society's Bronx Zoo

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Abstract - *Varanus prasinus* is a medium-sized arboreal varanid lizard that, while well-represented in captivity, remains enigmatic in the wild. Observations of this species in the wild have been scarce, and most of what is known about its behavior has come from observations of captive animals. This article describes an unusual underwater foraging behavior observed in a *V. prasinus* specimen kept at the Bronx Zoo. Given how little is presently known about the behavioral capabilities of this species, this behavior potentially adds yet another layer to the range of behaviors already observed in these lizards.

Introduction

Varanus prasinus is a primarily arboreal monitor lizard belonging to the *V. prasinus* species complex, a group of nine morphologically similar species which all exhibit similar tree-dwelling habits. These highly specialized lizards feature several morphological traits which enable them to fully exploit arboreal habitats, including elongate bodies, long prehensile tails, and subdigital scales that are believed to aid in gripping (Greene, 1986). Members of the *V. prasinus* complex also appear to exhibit a range of highly specialized behaviors related to foraging and prey capture (e.g., Hartdegen *et al*., 1999, 2000; Mendyk & Horn, 2011). Dietary studies on the stomach contents of field-collected museum specimens of *V. prasinus* and its kin have demonstrated that, as previously suspected, these lizards are primarily insectivorous (Greene, 1986; Struck, 2002). However, given the elusive nature of these lizards in the wild, of which very little has been reported, most of these behaviors have been observed only in captivity. Still, despite some species such as *V. prasinus* being kept in captivity for several decades, many aspects of their behavior remain unknown (Greene, 1986; Struck, 2002).

The Wildlife Conservation Society's Bronx Zoo has a long history of maintaining *V. prasinus* in captivity, and has successfully reproduced the species on several occasions since 2003 (Mendyk, 2012). In this report, I describe an unusual foraging behavior observed in a captive bred adult *V. prasinus* in the zoo's collection.

Description of Housing

A thirteen year old captive-bred male *V. prasinus* (ca. 90 cm in total length; ca. 451 g) has been housed together with an adult captive-bred female in an off-exhibit enclosure since 23 January 2013. The enclosure is comprised of two sections which rest on top of one another and are connected in the middle. The upper half of the enclosure is constructed primary of sealed plywood with mesh vents on the top and three side walls, and measures 105 x 72 x 76 cm (L x W x H). The bottom portion is made entirely of molded plastic and measures 105 x 72 x 59 cm. A custom rain chamber system constructed from PVC piping with a series of drilled holes spans the top of the enclosure, and is fed by the building's filtered water system. A bulkhead on the floor of the enclosure allows for excess water to be drained via the building drainage plumbing. The features numerous branches, vines, artificial *Ficus spp*. branches, and cork bark slabs and tubes which facilitate climbing, resting, and hiding.

Behavioral Observations

On 10 September 2013 at approximately 1530 h, the rain chamber function of the enclosure was activated. On this occasion, however, the drain became clogged with debris, causing the enclosure to fill with ca. 6.5 cm of water. As the enclosure door was opened in order to access and unclog the drain, the male *V. prasinus* was observed and video recorded performing an unusual behavior at the floor of the enclosure. While it is not entirely unusual for captive *V. prasinus* to soak or walk through shallow water, it became apparent in this case that the lizard was not only swimming (Fig. 1), a rare behavior for the species, but also actively foraging for food beneath the water's surface (Figs. 2-3).

The animal was seen swimming around the perimeter of the enclosure, probing its snout into the crevices where tree limbs met the floor (Fig. 2). While submerged, the lizard kept its eyes shut and tongue-flicking was not observed (Fig. 3). This did not appear to affect its ability to locate and capture prey, as several *Zophobas morio* larvae were captured underwater and consumed once the lizard had raised its head clear of the surface. The mechanism by which prey was located without the use of sight or olfaction is unclear, although tactile prey detection is a possible explanation.

It is also worth noting that several *V. prasinus* specimens at the Bronx Zoo have accepted aquatic prey items including small fish (shiners and goldfish) and crayfish, which would not otherwise be expected to be normal dietary items for an arboreal species.

Discussion

This behavior contrasts starkly with the underwater foraging behavior observed in semi-aquatic varanid lizards such as *V. mertensi*, which utilizes visual cues and is also the only varanid reported to successfully utilize olfaction underwater (Mayes *et al*., 2005). Instead, the behavior described here for *V. prasinus* appears to be more similar to underwater foraging in *V. panoptes* (Shannon & Mendyk, 2009). Although *V. panoptes*, like *V. prasinus*, lacks specialized aquatic adaptations such as the laterally compressed tail of *V. mertensi*, it has been observed exploiting freshwater mussels during the dry season when terrestrial prey may have been scarce (Shannon & Mendyk, 2009). It is possible that *V. prasinus* is also capable of this type of exploitative and opportunistic foraging behavior, although this article does not seek to conclusively establish underwater foraging as a normal behavior for *V. prasinus*. Since this

Fig. 1. *Varanus prasinus* swimming underwater.

Fig. 2. *Varanus prasinus* exploring the area where the perching and the floor meet. Note the *Zophobas morio* larvae on the branch in the foreground.

Fig. 3. *Varanus prasinus* lifting its head out of the water; its eyes are still closed from the submersion.

specimen was a long-term captive, this behavior may be unique to this animal and highly unusual, and has not yet been observed in any other *V. prasinus* in the collection. Nevertheless, given the scarcity of data concerning the foraging and prey handling behaviors of these lizards in the wild, this occurrence does merit documentation.

Acknowledgments - I would like to thank my colleagues in the Department of Herpetology, Wildlife Conservation Society's Bronx Zoo for their support during the writing of this article: Don Boyer, Kevin Torregrosa, Bill Orrico, Sarah Parker, Andrew Kathriner and Kelvin Alvarez. I would also like to express sincere gratitude to Robert Mendyk for his invaluable input and assistance throughout the preparation of this article.

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Juvenile *Varanus salvator* Predation on a Common Skink (*Sphenomorphus* sp.)

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The water monitor lizard, *Varanus salvator*, is a scavenger and generalist predator known to consume a wide variety of prey (Gaulke & Horn, 2004). Although insects have been documented as the primary diet of juvenile *V. salvator* (Gaulke, 1991; Traeholt, 1994), juvenile *V. salvator* may also hunt small animals such as skinks and frogs (Gaulke, 1991; Losos & Greene, 1988). Here, we note an observation of a juvenile *V. salvator* preying on a common skink (*Sphenomorphus* sp.)

On 17 September 2014 at approximately 1240 h, a juvenile (ca. 0.5 m total length) *V. salvator* was observed on a tree on Tinjil Island, Indonesia with a common skink (*Sphenomorphus* sp.) in its mouth. Upon closer observation, it became clear that the skink also held a section of the *V. salvator's* gular area in its mouth (Fig.

Fig. 1. Juvenile water monitor lizard (*Varanus salvator*) and common skink (*Sphenomorphus* sp.) biting each other, Photographed by **Linda Uyeda**.

Fig. 2. A juvenile *V. salvator* moving its head around in an apparent attempt to free itself from the grip of a common skink (*Sphenomorphus* sp.), Photographed by **Linda Uyeda**.

Fig. 3. Juvenile *V. salvator* holding a common skink *(Sphenomorphus* sp.*)* in its mouth, Photographed by **Linda Uyeda**.

1). Both individuals remained motionless for several minutes, after which time the *V. salvator* reared back and shook its head back and forth in what appeared to be an attempt to shake the skink free. Unsuccessful, the *V. salvator* continued approximately 5 m further up the tree with the skink still in its mouth and with the skink's mouth still gripping its gular area. The *V. salvator* was then observed maneuvering its head back and forth again, followed by apparent attempts to swallow the skink. Although the *V. salvator* was partially obscured by the tree by this point in the observation, the tail of the skink was still visible. At 1300 h, approximately 20 minutes after the start of the observation, the *V. salvator* moved to a location where it could not be seen, and the observation was concluded. Consumption of the skink was not observed.

Acknowledgments - We would like to thank Institut Pertanian Bogor (Bogor Agricultural University) Primate Research Center and the University of Washington Center for Global Field Study for supporting this research project and for providing logistical assistance. We are also grateful for financial support from the American Institute for Indonesian Studies and the University of Washington School of Environmental and Forest Sciences. This research has received approval from the Indonesian Ministry of Research and Technology, permit number 33/EXT/SIP/FRP/SM/VII/2014.

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The Use of an External Telemetric Device on *Varanus olivaceus*

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Abstract - An attempt to track a subadult *Varanus olivaceus* using an external radio transmitter 3% of the animal's body weight attached with a butyl waist belt failed after seven days because the transmitter detached from the belt and antenna. Attempts to recapture the animal and retrieve the device were unsuccessful, and camera trap evidence indicated that the belt and antenna remained on the lizard for between 773 and 799 days in total. It is postulated that the transmitter was forcefully detached as the result of the lizard entering a narrow hole or crevice, and that the intact device would have prevented the animal from entering preferred shelters by increasing its minimum girth. It is suggested that devices attached in this way are unsuitable for use on arboreal monitor lizards. The difficulties of retrieving devices attached to such animals are also discussed.

Introduction

Telemetric devices are regularly used in the study of free-living monitor lizards, providing data on location, movement, orientation, temperature, habitat use and physiological responses (*e.g.,* Stebbins & Barwick 1968; Sokolov *et al.*, 1975; Francaz *et al.*, 1976; Auffenberg 1981, 1988, 1994; Traeholt 1995, Gaulke *et al.*, 1999, Ibrahim 2000, Bolton & Moseby 2004, Ciofi *et al.*, 2007). More recently, Flesch *et al.* (2009) reported on the use of GPS loggers in the study of *Varanus varius*. The methods require that a device be attached to, or implanted into, the study animals. With a few exceptions (Thompson *et al.*, 1999; Sweet 1999, 2007; Heger & Heger, 2007; Smith & Griffiths, 2009), all field telemetric studies of monitors have used external transmitters, usually attached to animals by means of a waist belt or harness around the forelimbs. Although methodologies usually give detailed accounts of capture and attachment methodology, few studies report on whether the study animals were relieved of the devices after the study. Similarly, few studies consider the possibility that telemetric devices could have a detrimental effect on animals, although the assumption of negligible effects has not been tested for any attachment method.

In 2003 the Polillo Butaan Project hoped to use telemetry and GPS devices to investigate movement of the butaan, *V. olivaceus*, a large (< 190cm, 9500 g), highly arboreal frugivorous monitor lizard endemic to southern Luzon and two adjacent smaller islands in the Philippines. Risk assessment suggested:

1. Because of the very limited immune response and high susceptibility to infection of *V. olivaceus* reported by Auffenberg (1988 – see discussion), implanted devices were unacceptable.
2. Because *V. olivaceus* spends much of its time in an extremely cluttered environment there was a risk that any device attached to an animal would restrict its movements. Devices should therefore be of minimal size and attachments should be designed to minimise the risk of snagging.
3. Because *V. olivaceus* can live for at least several decades and continue to grow throughout life, any device attached permanently will eventually have a detrimental effect. Therefore, the animals must be recaptured and the devices removed at the end of the study.

Methods

As a pilot study, a Telonics (Mesa, Arizona, USA) MOD-125 transmitter 4.1 x 2.4 x 2.0cm) with a loose 40 cm monopole whip antenna in longitudinal TEA-2 configuration was attached to a young (45 cm snout to vent length [SVL], 2150 g) male *V. olivaceus* with a waist belt made of 2 cm wide butyl belting. The transmitter was attached to the belt at each corner with rivets and the total weight of the device was 65 g. To provide detailed information on behavior after release, we also attached a spool and line device consisting of two polyester cocoon bobbins to the proximal third of the tail with waterproof duct tape (total weight 18 g). The animal had been caught by a local farmer on the afternoon of 13 April 2003, in secondary forest near Sibulan Watershed Reserve, Pinaglubayan, Polillo Island, Quezon Province. It had no apparent injuries and was in good condition. It was released at 0630 h on 14 April at the point of capture.

Results

The animal was tracked by following spool and line thread on the late afternoon of 16 April to an emergent *Shorea* tree (106 cm in circumference, around 30 m high, with dense vine thickets in the canopy) that had scratches indicating it had been used previously by monitor lizards. Straight line distance between release point and shelter tree was 31 m, route taken was approximately 43 m. The signal from the telemetry device was detected with receiver and handheld Yagi antenna on the second, fifth, and seventh day after release. Between 17 and 19 April, the animal had descended the tree and the detached spool and line device was found 7 m from the shelter tree. Telemetry signal indicated that the animal had returned to the same tree and remained there until at least 21 April. After this date no further signals were detected, despite extensive searches that continued until 8 June 2003.

On 10, 12, 14 and 15 May 2003, the animal was recorded on a camera trap at a fruiting tree 316 m from the point of capture (Fig 1). The harness and antenna, but not the transmitter, were attached. From 8 June onwards, we attempted to catch the animal by waiting at the site in a camouflaged hide but the lizard did not reappear. We continued to monitor the tree where the animal had been recorded with camera traps (Bennett & Clements 2014) throughout its fruiting periods until 2006, together with other trees in the area, but the animal was not seen again until 27 May 2005 when it was recorded at a fruiting tree 400 m away from the original point of capture and 690 m from the tree where it had been photographed in 2003 (Fig 2). This tree had been monitored through fruiting seasons since 2003. The heavily worn harness and antenna were still attached to the lizard and it appeared to be in very good condition. On 22 June 2005, the same animal was recorded at the same tree, but it had lost the harness entirely (Fig 3). An abrasion, presumably from the harness, was visible on the ventral surface.

Fig. 1. *Varanus olivaceus*, 15 May 2003.

Discussion

Transmitter and harness durability

Two behaviors of butaan are likely to challenge transmitter durability. Like many (most?) monitor lizards, *V. olivaceus* likes to shelter in very tight spaces and (unlike most other monitor lizards) they habitually jump from trees at heights that sometimes exceed 15 m (pers. observ.). Auffenberg (1988) reported that flushed individuals would jump from as high as 30 m. Impact from high jumps could result in damage to transmitters. External transmitters could prevent the animal from entering a narrow hole, or (the most likely cause of

Fig. 2. *Varanus olivaceus*, 27 May 2005.

Fig. 3. *Varanus olivaceus*, 22 June 2005.

the failure reported here) be prised off by the animal's exertions to enter its shelter.

The radio failed, apparently due to detachment of the antenna, after only seven days. The harness become completely detached from the animal after 773-799 days and its appearance shortly before detachment suggested it had been worn out by friction. Therefore, it would have provided a suitably durable attachment for the transmitter which had an expected life of around 270 days. Auffenberg (1988) used harnesses of plastic coated stainless steel banding with a minimum breaking strength of 50 kg to attach > 60 g telemetry devices to *V. olivaceus* in a limestone karst area of Bicol, and reported that other harness materials tested (leather and nylon straps) were unsuitable because "of sharp rocks in the environment". Exposed rock is not a feature of the habitat of *V. olivaceus* in the Polillo study area, but a belt whose material is worn away by the environment is preferable in any habitat where the chances of recapturing the animal for device recovery is uncertain.

Effects on lizard

Other than the abrasion observed after detachment, no detrimental effects were evident from pictures of the lizard after 26 months of wearing the belt and antenna. It appeared to be in excellent condition and although a direct estimate of size in 2005 is not available, the animal had clearly grown. However, the fact that the transmitter was separated from the device shortly after release probably indicates that the intact device must have presented a severe hindrance to the animal's movements. There is surprisingly little literature documenting entanglement of experimental devices attached to lizards. Warner *et al.* (2006) reported eight instances of entanglement in a study of 53 *Amphibolurus muricatus* that were fitted with external transmitters for periods of one to over 21 days, and recommended frequent observations to minimize mortality. Because butaan spend all but a few hours of each week at least 10 m above the ground, such monitoring is impossible.

My observations on Polillo concur with Auffenberg's (1988) report that "the butaan regularly jams itself into tight places". On Polillo, the animals often use trees with holes that appear impossibly small, and many animals are photographed with lateral scrapes on the dorsal surface that I presume are made by entering narrow crevices. Clearly any attachment that increases the minimum girth of the animal will limit the number of tree holes it can enter. Therefore, neither waist belts nor chest harnesses are suitable attachment methods for crevice-dwelling monitor lizards, and the only external point of attachment that will not restrict entrance into cavities is the tail. Holland (2003) and Ujvari & Madsen (2009) attached telemetry devices to the lateral side of the tail of *V. panoptes* by wiring them between the caudal vertebrae. Whilst this method also requires intrusive surgery, it probably carries a much lower risk of systemic infection than coelomic implantation (see below), and greatly simplifies the (essential) process of device removal.

Use of implanted devices in V. olivaceus

Prior to this study, the only previous field work on *V. olivaceus* was conducted by Auffenberg (1988), who stated, "Though no definitive experiments have been conducted, butaans are in my opinion much more susceptible to serious infections than either *V. komodoensis* or *V. salvator*.… A number of the *V. olivaceus* brought to our Caramoan camp had been bitten by the dogs used to capture them. In practically every instance the *V. salvator* individuals recovered from internal bacterial infections arising from these wounds, whereas such infections were the cause of death of all such wounded *V. olivaceus*" (p. 150). Of 126 *V. olivaceus* caught during his study, 61 were injured by dogs (pp. 362-363). Perhaps not surprisingly, nobody has been willing to conduct the experiments required to answer questions about the immune systems of butaan, and consequently, the risks associated with coelomic implantation and removal are currently considered unacceptable. A study of the closely related species *V. mabitang* rejected the use of implanted transmitters for the same reason (M. Gaulke, pers. comm.)

Limitations of telemetry for V. olivaceus

Telemetry has enabled important insights into many aspects of monitor lizard biology (see particularly Tsellarius & Tesllarius 1997; Sweet 1999, 2007 for behavioral studies), but its application in the case of the butaan is complicated by the animals' arboreality, extreme shyness and vulnerability to even minor disturbance by people, and the very complex environment it inhabits. Because tree densities are high (over 1400 stems > 30 cm circumference per ha^{-1}) and trees are large (basal area in primary forest 65 m^2 ha, canopy height > 25 m), precise tracking requires that the tree be approached very closely. Nocturnal tracking is therefore essential to minimise the risk of disturbance to the lizards, and the method would not provide data about movement to resource trees other than among overnight shelters. Unlike the behavioral studies cited above, *V. olivaceus* is almost impossible to observe for more than two or three hours a week and any attempts to follow animals through forest would undoubtedly frighten them.

Recovery of Devices

In my experience, subsequent long-term avoidance of capture area is normal for *V. olivaceus* that are caught and released. However, it was anticipated that it would be possible to recapture this animal, even in the event of transmitter failure, by waiting for it to appear at a fruiting tree. Camera trap data indicates that butaan regularly return to the same fruiting trees year after year, and because some fruiting trees are extremely rare they attract many members of the local population. Unfortunately the behavior of this individual made it impossible to predict its location at any time, which essentially made it impossible to recapture.

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Notes on Breeding *Varanus albigularis microstictus* in Captivity

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Abstract – This article describes the husbandry and successful reproduction of *Varanus albigularis microstictus* in captivity. A total of 88 hatchlings have been produced over two successive years by a male and two females through a partnership between the author and the Mátra Museum. A further clutch of eggs laid by a second group of *V. albigularis microstictus* in the author's collection is currently incubating at the time of this writing.

Introduction

Varanus albigularis is a large varanid lizard (to 2 m in total length [TL]) that is commonly maintained in captivity. It was first hatched in captivity at the San Diego Zoo in 1962 (Staedeli, 1962), and has since been successfully reproduced on many occasions in both zoos and private collections worldwide. Several published accounts have documented cases of successful captive breeding (Bom & Bom, 1989; Davidson, 1993; Le Poder, 2007; Rese, 1983; van Duinen, 1983; Visser, 1981; Wesiak, 2006; Wesiak & Riedel, 2009). This article seeks to add to what is presently known about the reproduction of *V. albigularis* by documenting further instances of captive breeding in the subspecies *V. albigularis microsctictus*.

History and Husbandry of Adults

In 2009, the Mátra Museum in Gyöngyös, Hungary acquired a juvenile *V. albigularis* that was recently imported by a Hungarian reptile dealer. The lizard, which was later determined to be male, reached ca. 180 cm TL by 2012, and today measures 200 cm TL. At the Mátra Museum, this animal has been housed in a large terrarium measuring 300 x 230 x 240 cm (L x W x H). The terrarium is furnished with large tree limbs and a large water basin that the animal could submerge in. Bark and gravel were used as a substrate. A basking spot was generated by three 160 W infrared bulbs and a 160 W mercury vapor lamp which also provided UV light. Given the large size of the terrarium, two electric heaters mounted to the walls of the enclosure provided supplemental heat.

In November 2010, the author acquired a wild-caught subadult female *V. albigularis* (herein referred to as Female #1) that had been imported from Tanzania. Although the animal's exact age was unknown, based on its size at the time of its arrival (ca. 90-100 cm TL), age was estimated at around three years. A second wild-caught Tanzanian female (Female #2) was acquired in January 2013. The age of this animal, an adult measuring 150 cm TL at the time of its arrival, was unknown.

Outside of breeding introductions, each female is maintained in its own terrarium measuring 170 x 170 x 80 cm. An assortment of tree limbs and water bowls are offered as furnishings and bark is used as a substrate. Both have access to UV light produced by ReptiGlo 10.0 compact fixtures, and heating is provided by a 160 W infrared bulb and a flood lamp. Both animals are fed once or twice a week depending on the prey type, which may include fish (trout and catfish), small chicks and chicken parts (gizzard, heart, leg, wing, neck), and occasionally rodents. Both females typically experience a reduction in appetite beginning in late October which can last for two to three months; complete refusal of food for a few weeks is not uncommon. Disturbance to the lizards during this period is avoided.

Reproduction

2012

On 12 May 2012, Female #1 was introduced to the

Fig. 1. Copulation with Female #1 on 11 August 2012.

male's terrarium at the Mátra Muzeum. Copulation was first observed on 10 August, and continued over the next three days with each copulation lasting around one and a half hours (Fig. 1). During this period, the male was observed alternating the use of each hemipenis between copulations. The pair was left together in the terrarium after copulations had ceased.

During the period of copulations, an empty nestbox measuring 90 x 50 x 47 cm was constructed from wood and placed in the terrarium (Fig. 2). Two entrance holes measuring 15 cm in diameter were drilled; each on opposite ends of the box. Three quarters of nest box's cover could be opened for human access. After a week inside the terrarium for the female to investigate, the nest box was filled with 130 L of dampened peat. Digging was observed as soon as the female discovered the substrate in the nestbox, with all efforts focused in the corners. The female rarely left the nest box during this period.

On 27 September, the female spent the entire day inside the nestbox, and then began laying eggs the following morning (Fig. 3). By 1530 h, the female had laid 25 eggs. Another three eggs were discovered buried in the nestbox on 29 September, as the female rested atop the substrate inside. All eggs were removed from the nest (Fig. 4), weighed and measured (averaging 6.0 x 3.5 cm and 55 g), and placed in an incubator set to 29° C. Inside the incubator, the eggs were placed inside two different types of plastic boxes and partially buried in a 1:1 mixture of vermiculite and water by weight. One of the boxes was completely transclucent and measured 32 x 19 x 11 cm, while the other was white with only a transcluent lid, measuring 32 x 24 x 10 cm. Six small holes were made in the lid of each box, and eggs were checked weekly. Some water in the vermiculite was lost through evaporation and replaced according to the

Fig. 2. Nest box for V*aranus albigularis microstictus.*

Fig. 3. Female #1 depositing eggs in the nestbox on 28 September 2012.

Fig. 4. Egg of *V. albigularis microstictus*.

Fig. 5. Candling of the eggs reveals fertility.

Fig. 7. Newly emerged *V. albigularis microstictus* hatchling.

weight of the egg container. Although the eggs continued to be inspected regularly, water was not added to the boxes during the final three weeks of incubation.

By 10 October, one of the eggs had begun to smell foul and was dented, so it was removed from the incubator and dissected. Upon its dissection, the egg contained a gelatinous, yellowish-colored mass and appeared to be infertile. At this time, the other 27 eggs appeared viable and healthy (Fig. 5). Some of the eggs began to dent on 17 February 2013, suggesting imminent hatching. The first egg pipped on 24 February 2013 after 154 days of incubation (Fig. 6), with the hatchling emerging from its egg two days later (Fig. 7). Additional eggs began to hatch on 26 February and continued steadily up until 2 March. At 165 days of incubation, one egg began to show signs of deterioration and was dissected to reveal a fully-developed but deceased set of twins (Fig. 8). All remaining neonates hatched successfully by day 173 of

Fig. 6. The first *V. albigularis microstictus* pips its egg on 26 February 2013.

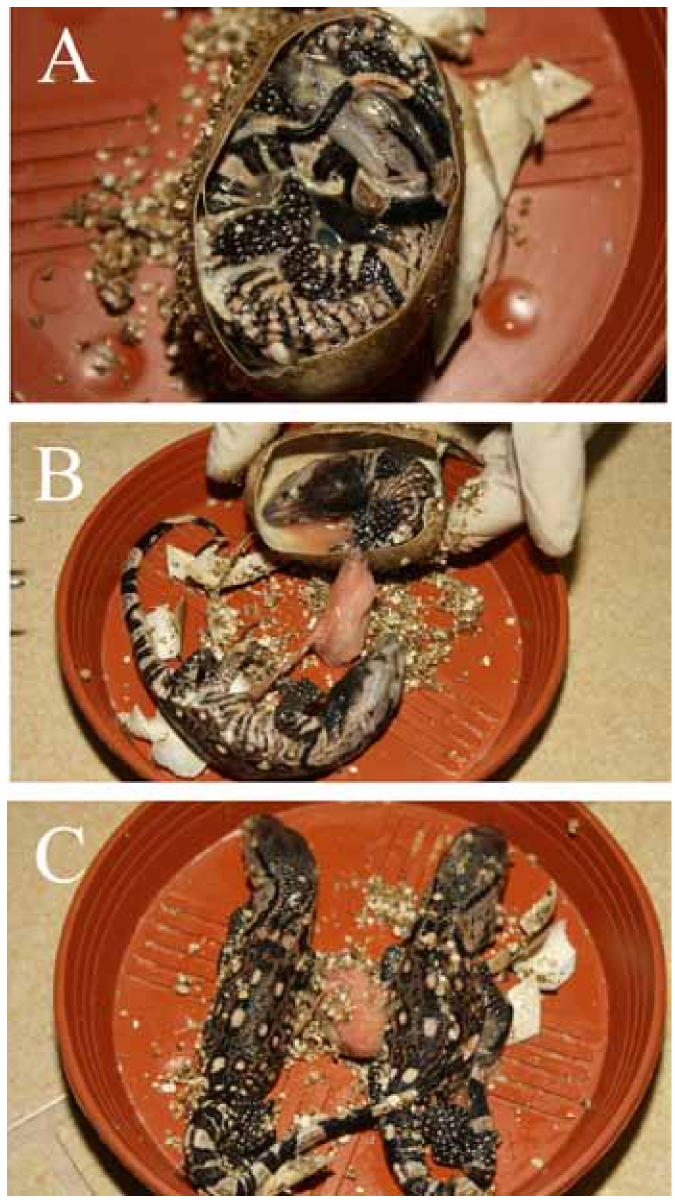

Fig. 8a-c. Deceased twin *V. albigularis microstictus*.

Figs. 9 & 10. Copulation with Females #1 and #2. in 2003.

incubation. Hatchlings ranged between between 30-40 g and had an average TL of 25 cm.

2013

Copulation was first observed between the original pair on 11 June 2013 (Fig. 9). On 18 June 2013, the second female was introduced to the existing pair's terrarium, resulting in copulations between the male and Female #2 the same day (Fig. 10). Female #2 began laying eggs on 15 July; unfortunately, all were scattered throughout the terrarium and none proved to be viable (Fig. 11). Although a few eggs were deposited in the nest box, these also proved to be infertile. In total, 35 eggs were laid by this female.

Around the same time, both females were seen frequenting the nestbox; sometimes, both were inside the box simultaneously (Fig. 12). This led to aggressive confrontations between the two females, with Female #1 regularly biting the legs and neck of Female #2 whenever they were both at the nest box. To limit this aggression and prevent Female #2 from entering the nestbox whenever Female #1 was inside, the entrances were closed off.

Female #1 began to deposit its eggs on 28 July, 48 days after the first observed copulation (same timespan as the previous year). Eighteen eggs were recovered from the nest box that morning and 17 more including one infertile were discovered in the afternoon. An additional 15 eggs were laid that night, four more were found buried in the next box the following day, and a crushed egg was discovered later that evening. The eggs were transfered to an incubator set to the same conditions as in the previous year. A total of 43 out of the 55 eggs from the clutch proved to be viable and healthy, with eggs averaging 6 x 4 cm and 48 g.

Female #1 remained inside the nestbox for the next three days, and attacked Female #2 and the author whenever the box was approached. Even though it was decided to remove the nestbox from the terrarium,

Fig. 11. Infertile eggs laid by Female #2 in 2003.

Fig. 12. Both females in nest box together.

Fig. 13. Newly emerged hatchling *V. albigularis microstictus*, 2013.

Fig. 14. Deformed hatchling missing lower jaw.

Female #1 continued to defend the area where the nest box was located. During this period, the male ignored both females and no aggressive interactions were observed between Female #1 and the male. Since aggression continued between the females, Female #1 was removed from the male's terrarium and returned to the author's collection.

The first egg pipped on 24 December 2013 after 151 days of incubation, with the hatchling emerging a few days later on 27 December. By 11 January 2014, a total of 42 neonates had hatched (Fig. 13), with only one egg remaining in the incubator. A small incision made in the egg's shell revealed a live neonate, so it was left in the incubator to hatch on its own. However, by 3 February, the egg had begun to smell foul. Dissection revealed a deformed neonate missing the lower jaw (Fig. 14). Two other deformities were present among the successfully hatched neonates from this clutch: one individual featured a kinked spine posterior to the pelvis, whereas the other had a stocky body and died a few days after hatching. Hatchlings averaged 25 cm TL.

On 8 August 2013, the male copulated with Female #2 again, resulting in a clutch of 36 eggs (eight of which were infertile) that was laid in the nest box 34 days later on 11 September (Fig. 15). Eggs averaged 7 x 4 cm and 54 g. Incubation parameters were kept the same as for previous clutches. During incubation, some of the eggs began to grow mould and were deemed infertile. Eggs began to pip on 15 February 2014 after 157 days of incubation, with the first neonate emerging from its egg on 17 February. All remaining hatclings emerged by 23 February (Fig. 16). A set of twins successfully hatched on 21 February; both animals appear to be healthy and continue to do well despite being substantially smaller than their siblings. Hatchlings averaged 25 cm TL.

2014

In 2014, Female #2 was kept together with the male for the entire year, whereas Female 1# was reintroduced to the group on 7 May. On 3 June, Female 1#, who measured 160 cm TL at the time, was found dead in the enclosure. There were no apparent signs of aggression between the animals and a necropsy was inconclusive due the animal's advanced state of decay. The terrarium was cleaned and sterilized, and the two remaining animals were separated as a precaution. Female #2 was returned to the author's collection, where breeding is

Fig. 15. Female #2 depositing eggs in 2013.

Fig. 16. *Varanus albigularis microstictus* offspring from 2013.

planned for the following year.

An additional pair of *V. albigularis* in the author's collection began maiting on 7 July 2014. Copulation between the male (150 cm TL), a three year old Tanzanian import acquired in December 2012, and the female (130 cm TL), a four year old adult female acquired in September 2013, took place over three days. Following copulation, two wooden boxes with dimension of 80 x 40 x 40 cm were joined together, and a hole 12 cm in diameter was cut into the box for nesting access. Shortly after its placement inside the enclosure, the female entered the nestbox, filled with dampened moss, spending an entire day inside.

On 26 August, 30 days after the first observed copulation, the female laid 27 eggs, of which one was infertile. Eggs averaged 55 g, and were set up for incubation using the same parameters as before. This clutch is still incubating as of this writing and is expected to hatch around February-March 2015.

Husbandry of Hatchlings

Hatchlings were intially housed together in groups of 10 in terrariums measuring 100 x 50 x 50 cm. For the first 1-2 months, newspaper and paper towels were used as a substrate, and water bowl was available for soaking. Each terrarium is heated with a 70 W flood lamp and illuminated by a ReptiGlo 10.0 compact fixture. As they grew, the newspaper was switched to a fine bark substrate, and virgin cork bark was added to each terrarium for refuge.

For the first few months, hatchlings were only fed insects (crickets, locusts, roaches). Later, superworms and pinky mice were added, as well as small chick heads on occasion. Once large enough to accept mice, they were fed only after defecating their previous prey meal. Vitamin supplementation is always offered with their food.

Maintaining the juveniles together in groups was unproblematic until they began taking rodents. When offered mice, the animals would fight over the same food items, and eventually had to be fed separately. Additionally, when animals consumed too many mice, they often regurgitated. As of this writing, a new enclosure system is being constructed for individually housing the juveniles.

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First and Repeated Cases of Parthenogenesis in the Varanid Subgenus *Euprepiosaurus* (*Varanus indicus* Species Group) and the First Successful Breeding of *V. rainerguentheri* in Captivity*

*The main part of this article is a translation of the recent report by J. Grabbe. 2014. Erster Nachweis von Parthenogenese bei *Varanus rainerguentheri*, einem Pazifikwaran aus der *indicus*-Gruppe. Terraria/Elaphe 2014(6): 38-42. Note that some modifications and additions were made in this translation by A. Koch.

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Abstract: We report the first and, at the same time, repeated cases of parthenogenesis in the *Varanus indicus* (Daudin, 1802) species group of the varanid subgenus *Euprepiosaurus* Fitzinger, 1843 and provide the first account of successful breeding of *V. rainerguentheri* Ziegler, Böhme & Schmitz, 2007 in captivity. Between 2012 and 2014, several clutches were laid by a female specimen, two of which each contained one viable egg that were both successfully incubated at 26°-31°C for 193 and > 200 days, respectively. The parthenogenetic hatchlings differed slightly in coloration and measured 26.5 cm and 27 cm in total length (TL). After 18 months, the first juvenile had a TL of 85 cm. Since parthenogenesis not only occurs in the evolutionarily younger (*i.e.*, derived) monitor lizard subgenera *Varanus* and *Odatria*, but also in the basal African clade of *Polydaedalus*, we assume that all monitor lizards are able to reproduce uniparentally. Therefore, we strongly encourage all monitor lizard keepers of single specimens that unexpectedly deposit eggs to incubate them and record all data on what may possibly result in parthenogenetic offspring.

Introduction

Parthenogenesis, the ability of organisms to reproduce unisexually (*i.e.* without males), is a rather common phenomenon in squamate reptiles (Schön *et al.*, 2009), but was only recently reported in monitor lizards (Lenk *et al.*, 2005). Genetically, the offspring of parthenogenetic monitor lizards are always males (arrhenotoky), and thus not clones of their mother, because female monitor lizards have two different sex chromosomes (Lenk *et al.*, 2005; Kearney *et al.*, 2009; Matsubara *et al.* 2014). The evolutionary significance of parthenogenesis is probably that it enables species to conquer new habitats; *e.g.*, an island that is successfully colonized by a single female specimen.

Since the first discovery of parthenogenesis in *V. panoptes* (see also Wiechmann, 2011; 2012), other such cases have been recorded in *V. komodoensis*, *V. ornatus*, and recently *V. glauerti* (Watts *et al.*, 2006; Hennessy, 2010; Hörenberg, 2013), thus representing

Fig. 1. Adult female *Varanus rainerguentheri* that repeatedly produced parthenogenetic offspring.

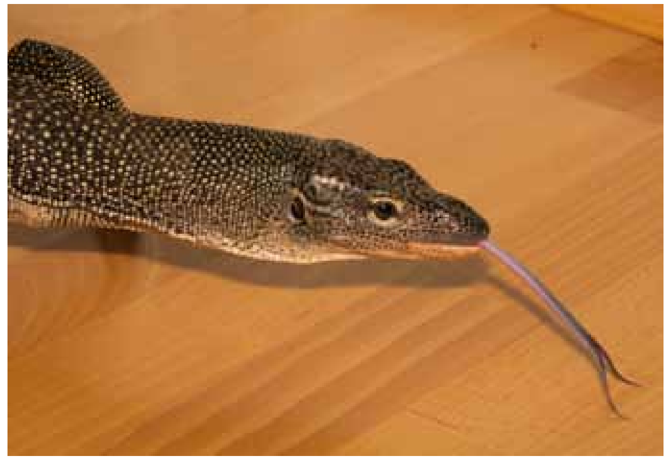

Fig. 2. Portrait of the female specimen. Note the light temporal stripe and the flesh-colored tongue that becomes darker toward the bifurcation.

three distinct subgenera of varanids (*Varanus*, *Odatria* and *Polydaedalus*). For most subgenera, however, records of parthenogenesis are still lacking. Here, for the subgenus *Euprepiosaurus* Fitzinger, 1843, we report the first documented and, at the same time, repeated cases of parthenogenesis in *V. rainerguentheri* in captivity.

The Female *Varanus rainerguentheri* and its Housing

Varanus rainerguentheri was described in 2007 by Ziegler *et al*. (2007a) from the island of Halmahera (Moluccas). It belongs to a complex of species related to *V. indicus* which has the largest distribution range of all monitor lizards (Mertens, 1942; Philipp *et al*., 1999; Ziegler *et al*., 2007b; Koch *et al*., 2009). Until recently, very little information was available on *V. rainerguentheri* and no observations on its reproduction have been reported to date (Weijola, 2010; Somma & Koch, 2012).

The parthenogenetically reproducing specimen described in the present article (Figs. 1 & 2) was initially determined by the senior author to be *V. indicus* ssp. due to differences in the head shape of the holotype of *V. rainerguentheri* as depicted by Ziegler *et al.* (2007a, Fig. 5). Comparisons with photographs of further specimens from the wild (see Weijola, 2010) and from museum collections (see Somma & Koch, 2012), however, suggest the holotype may simply have a pathologically shortened snout. Since the specimen otherwise agrees well with *V. rainerguentheri*, *e.g*. in color pattern and tongue coloration, it was later taxonomically assigned to this species.

The female *V. rainerguentheri* was purchased by JG in early 2009 as an imported wild-caught specimen. Fearing aggression with conspecifics, it was raised separately. Therefore, it never had contact with other (male) monitor lizards since it was acquired. As the specimen measured only 35 cm in total length (TL) when purchased (suggesting an age of 1-2 months) the possibility of an earlier copulation can be ruled out. Today, the female has a TL of more than 120 cm, with a snout-vent-length (SVL) of more than 50 cm and a mass of 3 kg. The terrarium measures 3 (temporarily only 2 m) x 1.2 x 2m (Fig. 3). The enclosure's artificial lighting is provided by modern LEDs, 80 W PAR-basking spots and 70 W UV-lamps (Raptor Solar). The water basin is filtered and heated. The terrarium's supply of fresh air is regulated by a temperature sensor that controls small circulating fans. Large tree trunks and a variety of

Fig. 3. The female's first terrarium.

Fig. 4. Two eggs from the first clutch that produced a parthenogenetic hatchling.

cork oak branches in combination with cork-lined walls maximize activity for the specimen. The substrate is comprised of a 20 cm layer of pine bark mulch. During the day, air temperatures in the enclosure are between 26-48 °C (from refuge sites to the basking spot) with 60-80% humidity and a water temperature of 26-29 °C. At night, air temperature drops to 24-25 °C with 85-98 % humidity and the water temperature measures 24-25 °C. A broad range of prey items are offered including insects such as grasshoppers and worms, a variety of fish (catfish, redfish, pollock, zander etc.), seafood (octopus, organic tiger shrimps, bivalve shellfish, *etc*.), and occasionally mice and young chickens.

Egg Deposition and Incubation

Under the conditions described above, the young specimen grew quickly and was first considered to be male. In November 2012, however, the obvious female began digging intensively in the soil for several days and shortly thereafter, four eggs were scattered throughout the terrarium. Comparing the eggs' appearance with photographs from the literature of fertilized eggs from closely related species revealed that they were narrower, but two of them seemed viable (Fig. 4). These had a similar shape and were about 70 mm long. Since several cases of parthenogenesis in other monitor lizard species were known (see above), these two eggs were not discarded. For incubation, they were transferred into a plastic box filled with a mixture of pine bark mulch with some humid peat, and the eggs were half-buried in this substrate. Due to the slim possibility that the two eggs were viable and because there were no other reptile eggs to incubate at that time, incubation was conducted provisionally the following way.

Since constantly high temperatures and humidity are important factors for successfully hatching reptile eggs, the incubation box was placed inside the light box above a tropical freshwater aquarium housing discus fishes. To protect the eggs from condensation, the box was covered with an angularly-folded section of aluminum foil. The water in the aquarium had a temperature of at least 29 °C all day. In addition, during daytime the T5 fluorescent tubes were on, so the eggs were incubated at temperatures between 26.5 and 31 °C. Candling the eggs was not successful, since the usage of stronger lamps was avoided in order not to risk injuries. Irregularly, the substrate in the box was sprinkled with water. After 3 or 4 months, the condition of one of the two eggs worsened. It shrunk and darkened, and was unfortunately discarded without determining if it contained an embryo. In contrast, the last of the four eggs still looked viable.

In the literature on breeding *V. indicus* and *V. juxtindicus* (Wesiak, 1993; Kok, 1995), an incubation period between 150-182 days is given. Higher temperatures result in shorter incubation periods. After about 180-190 days of incubation, JG was about to discard the last egg, but on day 193 in May 2013, the egg hatched (Figs. 5 & 6).

The long incubation period was probably the result of the rather low incubation temperatures (26.5-

Fig. 5. First parthenogenetic hatchling of *V. rainerguentheri* in the provisionary incubator box.

31 °C) when compared to 26-34° (sometimes even higher; see Kok 1995) and (28.5-) 29.5-30 °C (Wesiak, 1993). That the egg developed well despite the lower incubation temperature demonstrates how robust some varanid embryos can be. Another possible factor could be that *V. rainerguentheri* represents a distinct species which shows idiosyncratic differences in reproduction when compared to other Pacific monitor lizards. In any case, under normal conditions a special incubator in combination with vermiculite would be preferred.

Husbandry of the Juvenile

The hatchling had a large yolk sac and appeared completely healthy. It weighed about 26 g and had a TL of 27 cm and a SVL of 10 cm. For hygienic reasons, it was kept in a 30 cm cube terrarium the first few days with paper as a substrate (which was replaced every day) and some branches that were boiled for disinfection. A small cup with water was provided, although it was not sure if the young monitor would use it. It was only observed while running through the water sometimes. The yolk sac disappeared after two days; the umbilical wound healed very quickly and was gone four days after hatching. Crickets were offered and accepted on the third day. In the literature for *V. indicus,* 4-5 days or even more have been reported as when the first food items are taken by hatchlings. Every food item was supplemented with Herpetal Complete T and occasionally with liquid vitamins (Vitacombex). The specimen grew fast and remains healthy.

During the first three months, the juvenile was housed in a terrarium measuring 80 x 50 x 50 cm structured with cork oak branches, a 40 cm long swimming feature, and some plants (Fig. 8). Lighting was provided by a 20 W T5 fluorescent tube, a 50 W PAR-Spot for warming up in the morning only, and a UV-lamp (35 W Raptor Solar) for the entire day. A general warning shall be made here. Do not use compact energy save lamps, since they seem to have a very unsuitable spectrum of UV light and could potentially damage the eyes of reptiles! For a few days only, such a lamp (Dragonlux) was used for the hatchling's terrarium, which resulted in decreased activity and the animal constantly closing its eyes. When the lamp was replaced, the behavior of the animal returned to normal. The climatic conditions in the enclosure were nearly identical to those of the adult specimen. During the day, temperatures ranged from 26 to 45-50°C (between refuge sites and directly under the

Fig. 6. Ventral side of the first hatchling. Note the orange colored throat and the yolk sac.

Fig. 7. The first juvenile after some weeks still showing the orange colored throat.

Fig. 8. The juvenile's first terrarium.

Fig. 9. The first juvenile after three months. Note the change in dorsal color pattern from tiny yellow dots of only 2-4 scales on a black background to larger dark ocelli containing yellow spots of up to eight scales on a dark gray background.

Fig. 10. The second terrarium for the first juvenile.

Fig. 11. Through regular contact with the keeper, the first juvenile became tame. Notably, the orange colored throat has faded.

Fig. 12. The first juvenile after 17 months with a total length of about 80 cm. The dorsal color pattern of well-defined ocelli has dissolved. In addition, the laterally flattened and indistinctly banded tail with a dorsal double crest is clearly visible.

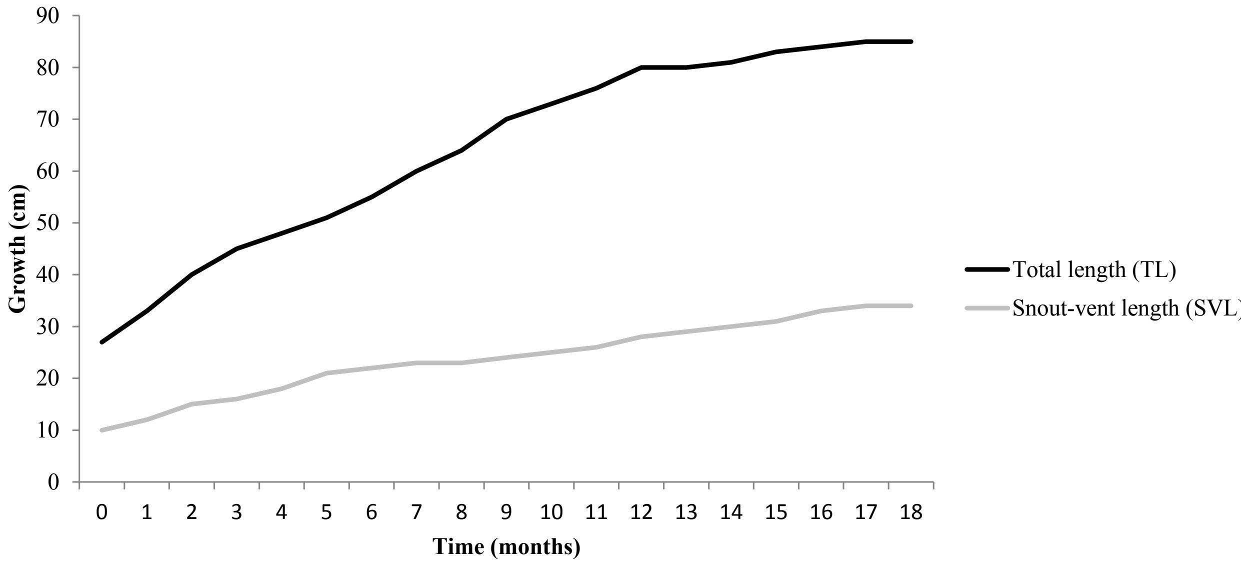

Fig. 13. Growth rate for the first hatchling *Varanus rainerguentheri* over the first 18 months.

basking spots) with a humidity of 40-70%, (but much higher in refuge sites so that the monitors could choose their preferred microclimate). At night, the temperature was 24 °C with 70-85 % humidity.

Interestingly, the dorsal color pattern of the juvenile changed considerably during the first few months. In the beginning, the pattern consisted of tiny yellow dots of only 2-4 scales on a black background coloration (Fig. 5). After some time, however, the pattern changed into larger dark ocelli containing yellow spots of up to eight scales on a dark gray background coloration (Fig. 9). At about this stage, the specimen received a larger terrarium measuring 150 x 80 x 100 cm (Fig. 10).

The young specimen swam and climbed much like the adult female, and dug tunnels in the soil. For the first 4-5 months the juvenile was shy, fleeing into the water when afraid, and hiding underwater, not coming up for air for many minutes. In the wild, this behavior is probably a tactic to escape from predators, and in mangroves, it must be extremely difficult to catch them. After a few months of dedicated handling, however, the juvenile became tame and took food from tweezers or directly from the hand. It even climbed on the arms of the keeper (Fig. 11). This has helped to reduce stress during handling for both the monitor lizard and the author. The wild-caught adult *V. rainerguentheri* is also very relaxed, trusting and good to handle. Minimal stress could also be an important factor in rendering the species easier to reproduce in captivity.

A Second Case of Parthenogenesis

The first hatchling from 2013 stayed with JG (Fig. 14). In the future, this animal is planned to be housed together with its mother in a large enclosure measuring

Fig. 14. Current terrarium for the first offspring.

Table 1. Incubation data for *Varanus rainerguentheri* compared with available data from the literature.

Incubation period (days)	Temperature (°C)	Total length of hatchlings (cm)	Weight of hatchlings (g)	References
158-174	28.5-30	27-28	23-26	Wesiak (1993), Wesiak and Koch (2009): *V. juxtindicus*
182	26-34	27-31	-	Kok (1993): *V. indicus* (?)
193	26.5-31	27	26	This study: First hatchling of *V. rainerguentheri*
> 200	26-30	26.5	-	This study: Second hatchling of *V. rainerguentheri*

Fig. 15. Second parthenogenetic hatchling *V. rainerguentheri* lacking an orange colored throat and showing a generally darker coloration.

Fig. 16. Second juvenile after few months showing black ocelli containing only small yellow spots.

3.2 x 1.2 x 2 m. Incubating eggs from eventual copulations between the female and its parthenogenetic son will not take place, because of the increased risk of genetic defects. However, between the end of 2012 and the end of 2014, the female produced some additional clutches. Clutches comprised up to 9 eggs; some were eaten by the monitor lizard, but most were obviously not viable for incubation since they were too soft, shrunken, or grew mold after a few days. Nevertheless, it was possible to incubate one further egg successfully (Fig. 15). Deposited in the end of 2013, it hatched on 18 August 2014. This suggests that the incubation period must have been more than 200 days. Unfortunately, the incubation period was not precisely documented. Two hundred days represents a very long incubation period for the species and is probably related to the somewhat lower temperatures experienced during incubation (26-30 °C). When the second hatchling was discovered, the yolk sac had already been absorbed.

Some coloration differences existed between the two juveniles. The first hatchling had an orange colored throat (Figs. 6, 7), which was not the case in the second offspring; its throat had a generally darker coloration (Figs. 15, 16). Despite these minor differences in coloration, this hatchling was as healthy and agile as the first juvenile. After a few weeks, the second specimen looked more similar to the first hatchling, but was still darker and the bright centers of the black ocelli comprised only one or two scales (Fig. 16). These individual differences in coloration between hatchlings demonstrate how difficult it may be to exactly distinguish the various closely-related species of the *V. indicus* complex at such early stage. The second hatchling is planned to be sent to another dedicated keeper. Since there are certainly more specimens of *V. rainerguentheri* in Europe and the USA (either wild-caught or allegedly farm-bred), there is a good chance for interested keepers to find a female and successfully breed them sexually.

Outlook

Since parthenogenesis not only occurs in the evolutionarily younger (*i.e.*, derived) monitor lizard subgenera *Varanus* and *Odatria*, but also in the basal African clade of *Polydaedalus* (Ast, 2001; Vidal *et al*., 2012), we assume that all monitor lizards are able to reproduce uniparentally. Therefore, we strongly encourage all monitor lizard keepers of single specimens that unexpectedly deposit eggs to incubate them, record all data, and publish them in order to make these findings and observations generally available.

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