BIAWAK

Journal of Varanid Biology and Husbandry

Volume 13 Number 2

ISSN: 1936-296X

On the Cover: *Varanus macraei*

The Blue tree monitors, *Varanus macraei* depicted on the cover and inset of this issue were hatched on 14 November 2019 at Bristol Zoo Gardens (BZG) and are the first of their species to hatch at a UK zoological institution. Two live offspring from an original clutch of four eggs hatched after 151 days of incubation at a temperature of 30.5 °C.

The juveniles will remain on display at BZG until they are eventually transferred to other accredited European Association of Zoos & Aquariums (EAZA) institutions as part of the zoo breeding programme. Text and photographs by **Adam Davis**.

BIAWAK

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 varanid 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.

ISSN 1936-296X

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Varanus hamersleyensis. Dale's Gorge, Karajini National Park, Western Australia. Photographed by **Steve Sharp**.

ORGANIZATIONAL NEWS

Continued Growth

Biawak continues to grow in terms of its global reach and readership. The period between July 2017 and December 2019 saw the addition of 279 new members, bringing IVIG membership to a total of 1,404 individuals from 60 countries. The IVIG's social media group on Facebook.com entitled "*Biawak - International Journal of Varanid Biology and Husbandry*" continues to grow at an even faster rate, now totaling 3,219 current participants as of December 2019.

Photographic Liaison Needed

The IVIG is seeking to add a new position to its editorial board, which will assist with securing photographic material for issues of *Biawak*. This photographic liaison position is a volunteer role; for more information, please contact the editor (e-mail: mendykr@si.edu).

Web Developer Needed

The IVIG is seeking an experienced individual familiar with basic website design to assist with creating a new and updated website that will host *Biawak* and the other informational resources of the IVIG. This is a volunteer position; for more information, please contact the editor (e-mail: mendykr@si.edu).

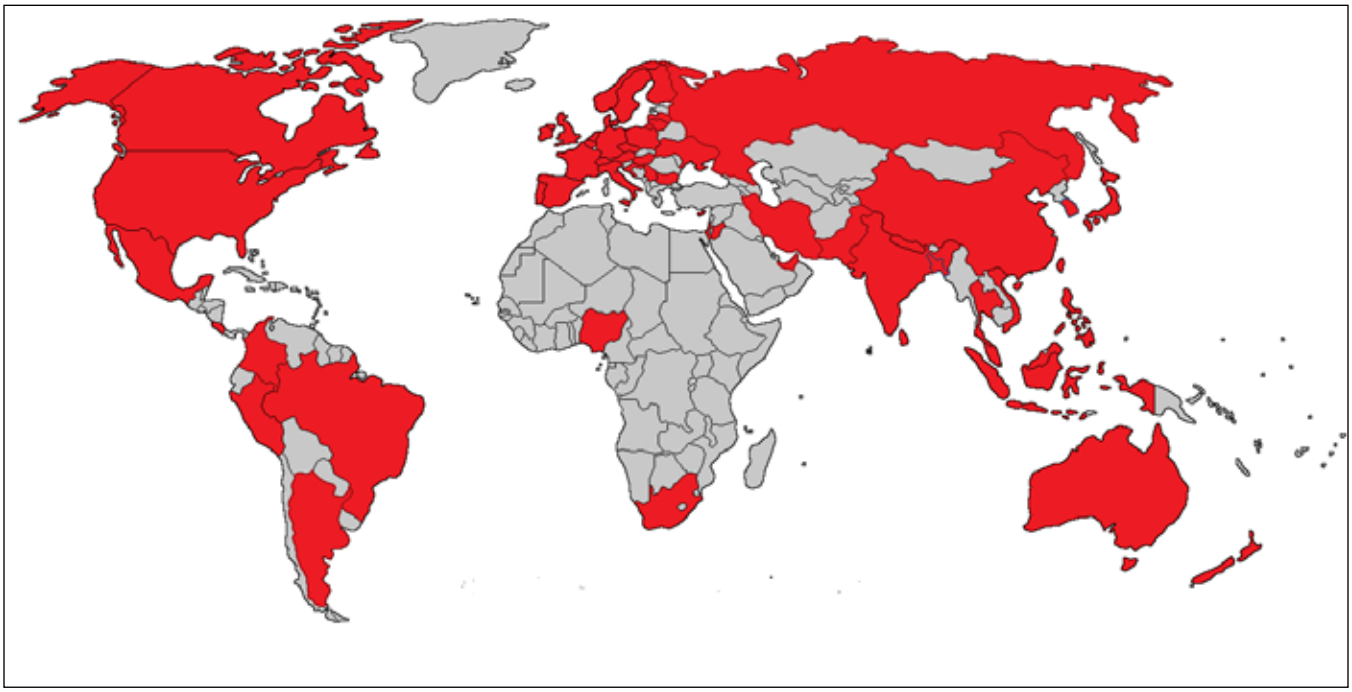

Fig. 1. Current global distribution of IVIG membership.

NEWS NOTES

Man sentenced for smuggling Philippine monitors

A federal judge sentenced a New Hampshire man to two years probation and 120 hours of community service for illegally importing more than twenty live monitor lizards from the Philippines. The 26-year-old man pleaded guilty to trafficking the animals over a nine-month period in 2016. The lizards were taped inside socks and then hid inside audio speakers to avoid customs. The species were not identified, but are presumably members of the *Varanus salvator* species-complex found among the islands. The man admitted selling some of the animals; the fate of the others was not given.

Source: www.masslive.com; 15 August 2019

Komodo dragons hatch at Chattanooga Zoo

Three Komodo dragons (*Varanus komodoensis*) have hatched at Chattanooga Zoo; the first to be reproduced at that facility. The zoo's dragon breeding facility opened last year with one pair of adults; a female named Charlie and a male named Kadal. Zoo officials had observed no breeding activity and are currently investigating whether the young are the product of parthenogenesis. The hatchlings will briefly be put on public view. At some later date, they will be put on permanent display in the zoo's Forest of the World exhibit.

Source: The Chattanoogan; 5 September 2019

Officials announce membership plan to enter Komodo Island

Following plans announced earlier this year to close Komodo Island to tourists for a year as a protective measure for the resident Komodo dragon (*Varanus komodoensis*) population, Indonesian officials have instead decided on an increase in the entrance fees for the island. The current entrance fee of $10 will be increased to a $1,000 "membership" fee, where individuals who pay the fee will be allowed to enter for a year. In addition, island residents – for whom initial plans included relocation – will now be allowed to remain. The changes to the park were first announced in July, as officials have become concerned that increasing tourism threatens the dragons. In 2018, 176,000 people visited Komodo.

Source: BBC; 1 October 2019

Boy attacked by water monitor in Malaysia

A three year-old boy was attacked by a water monitor (*Varanus salvator*) that had entered his father's office at a resort on Pulau Tioman, Malaysia. The 1.5 m long animal grabbed the boy's right foot as he was playing under the resort's registration desk. The boy's father stated that he had to step on the animal twice to get it to release it grip. The boy was taken to a local physician where it was determined that the injuries were severe enough to warrant hospitalization. The father noted that this same animal had entered the resort and had to be driven off on a number of occasions.

Source: New Strait Times; 8 October 2019

Couple arrested smuggling tree monitors

Two individuals arriving from Kuala Lumpur, Malaysia were detained at an airport in Chennai, India, as they attempted to smuggle a collection of reptiles. Among other reptiles, the pair possessed black tree monitors (*Varanus beccarii*), emerald tree monitors (*V. prasinus*), blue tree monitors (*V. macraei*), and Reisinger's tree monitors (*V. reisingeri*). The two were stopped by customs officials after they began moving suspiciously and then attempted to rush to the airport exit. The animals were found inside their luggage, bound with rope. All of the animals were said to be in good condition. Officials plan to return them to Malaysia.

Source: International Business Times; 11 October 2019

Men suspected of smuggling Perenties

Two individuals were referred to prosecutors in Japan for smuggling two Perenties (*Varanus giganteus*) into the country. The two – one a pet shop owner from Atsugi, Kanagawa Prefecture – allegedly brought the animals from Hong Kong into the country on different occasions in 2017 and 2018. Four other individuals were referred for engaging in the illegal transactions involving the animals. One was sold to a pet shop owner for 3.3 million yen ($30,000), while the other went to a private collector for 6 million yen ($55,000). The men allegedly told customs authorities that they were importing a different, undisclosed species.

Source: Kyodo News 26 November 2019

Varanus tristis. Dale's Gorge, Karajini National Park, Western Australia. Photographed by **Steve Sharp**.

Varanus macraei bred at UK zoo

Two blue tree monitors (*Varanus macraei*) hatched at Bristol Zoo Gardens in the UK, marking the first time this species has reproduced at a zoo in that country. It was noted that there are only seventy members of the species kept in captivity (presumably, referring to accredited zoological facilities). Zoo officials have not announced any long-term plans for the two.

Source: The Irish News; 4 December 2019

Chinese customs intercept smuggled monitor lizards

Two suspects were arrested by customs officials in China's Shanxi Province in early December for smuggling lizards into the province from Taiwan. A seller in Taiwan allegedly mailed two packages to the province, which were intercepted by customs at the local airport. Inside the seized packages were 58 dead savannah monitors (*Varanus exanthematicus*) and green iguanas (*Iguana iguana*). Officials later learned that the suspect had previously sent 173 individuals of these species to buyers in several Chinese provinces.

Source: http://www.xinhuanet.com; 21 December 2019

New species of monitor lizard described

A new species of monitor lizard belonging to the *Varanus indicus* complex of the subgenus *Euprepiosaurus* has been described. The species, *Varanus colei*, originates from the Kei Islands of Maluku Province, Indonesia, and represents the 16th species of this group.

Source: Böhme, W., H.J. Jacobs, T. Koppetsch & A. Schmitz. 2019. The Kei Islands monitor lizard (Squamata: Varanidae: *Varanus*: *Euprepiosaurus*) as a distinct morphological, taxonomic, and conservation unit. Russian Journal of Herpetology 26(5): 272-280.

Annual Meeting of the DGHT Warane und Krustenechsen Working Group 18-20 October 2019

Following the jubilee conference on the occasion of the 10th anniversary of our working group in 2018, which was held at Zoo Frankfurt a.M., the expectations of the members for 2019's meeting were accordingly high. This year's host, the Reptilium in Landau under the direction of Uwe Wünstel, offered an ideal location with a great atmosphere.

To kick off the meeting, we met on Friday evening in the foyer for a cozy champagne reception and lively exchange. At 2000 h, Markus Patschke from Zoo Dortmund reported on his travel experiences on the Indonesian island of Komodo. Visibly excited, the audience followed his fascinating descriptions. Afterwards, some attendees stayed in the main hall for a nice drink.

On Saturday morning, we began after welcome addresses by the working group chair and the DGHT presidium, represented by Matthias Jurczyk, and the host Uwe Wünstel who briefly introduced the Reptilium. Esther Laue from Dresden presented the first lecture of the day on her generously sized terrarium for *Varanus kingorum*. The main focus here was on naturalistic, lumen-intensive lighting of the enclosure.

After a lively discussion on this exciting topic, Sebastian Scholz (Frankfurt a.M.) then gave interesting insights into the keeping and breeding of *Varanus varius*, a hitherto rare and infrequently bred large varanid in European terrariums. Mr. Scholz has already succeeded several times breeding both color morphs of this species.

After the lunch break, we dedicated ourselves to the first scientific topic of the day. André Koch reported on the latest news on international monitor lizard research, including the activities of the IUCN Monitor Lizard Specialist Group and the results of his student Tim Pilch, who has worked on the scales and pores of the soles of the feet of monitor lizards.

After these exciting insights into current scientific projects of monitor lizard researchers, Anne Mühlemann from Switzerland and the well-known book author Dr. Hans-Joachim Schwandt (Asslar) gave a talk on the North and Central American beaded lizards with fascinating pictures and impressions from herpetological journeys into their habitat as well as the latest findings on the keeping and natural history of *Heloderma suspectum*.

Strengthened by the coffee break, Andreas Krb from the company Reptiles Expert explained the effects and functionality of modern UV lamps used in terraristics. Monitor lizards are especially known to be extremely heliophilic lizards, and therefore proper lighting of their terrariums is important.

The last program item of the day was the annual general meeting. In addition to some internal activities of the working group which were discussed, the election of a new treasurer also took place. For the current term of office, Esther Laue will direct the financial assets of the working group. She has many years of experience in this responsible role and has been unanimously appointed as the new Treasurer.

After the pretty full program of presentations, we went for dinner to the nearby restaurant Piccola Italia, where we ended the evening with excellent cuisine and interesting discussions.

On Sunday morning, we began the second day of talks with another report from Esther Laue's experiences. This time, it was about tree monitor lizards and intraspecific conflicts, how to recognize them, and what to pay attention to in order to avoid such conflicts. This presentation, as usual, included instructive tips from her many years of experience.

Our Swiss member, Pius Feierabend, gave the last presentation for this year's conference, a general keeping report on the small monitor lizards of the subgenus *Odatria*. Here, we received insights into frequently kept species, but also rather rare representatives in the European hobby as well as those that are not kept at all.

The concluding highlight of the conference was an exciting 90 minute guided tour by Uwe Wünstel through public and behind-the-scenes areas of the Reptilium Zoo. The Reptilium is home to several species of monitor lizard, such as *V. glauerti*, *V. reisingeri* and a melanistic form of *V. salvator*. The many questions from the participants expressed their great interest.

On both days, bulbs from our sponsor, Reptiles Expert, could be acquired, as well as some signed

Fig. 1. Attendees of the 2019 annual meeting of the DGHT Warane und Krustenechsen working group.

copies of Dr. Schwandt's new book on beaded lizards. In addition, the new book project on monitor lizards by Gunther Schmida was briefly presented by Bernd Eidenmüller.

All in all, it was once again a great program that provided interesting contributions for each conference participant. We would like to especially thank all present members and guests (Fig. 1), but also above all our host Uwe Wünstel and the team of the Reptilium, as well as Andreas Krb of Reptiles Expert (Vienna) for their great support, and all the speakers, who with much effort have contributed their part to the success of the meeting.

- Thilo Böck & André Koch

ASMP Reptile Taxon Advisory Group - Large Varanid Workshop

Recently, the Australian Reptile Taxon Advisory Group (TAG) in partnership with the Australasian Society of Zoo Keeping (ASZK) held a joint workshop on the captive husbandry and ecology of large varanid lizards. A particular focus of the workshop was on the Komodo dragon based on its ecology and learnings from other regions, as well as fostering improvements in the captive husbandry of large varanid species.

The workshop was held from 20-23 October 2019, with a meeting of the Australian Reptile TAG following on 24 October. Held in Alice Springs, Australia, the workshop attracted over 50 participants (Figs. 1, 2 & 4) including individuals from Australia, the United States, Singapore, New Zealand and Papua New Guinea - likely the largest gathering of zoo-based reptile keepers to have ever occurred in Australia. Due to the unique location of the workshop, participants were able to observe various reptile species in the field, with highlights including *Varanus giganteus* (Fig. 5)*, Morelia bredli, Moloch horridus, Nephrurus amyae* and *Pseudechis australis* sighted by a number of participants. Tours of the Alice Springs Desert Park (Fig. 3) and Alice Springs Reptile Centre were also incorporated into the event.

Workshop organizers wish to acknowledge the various sponsors who made this event possible, including Zoo Med, Arcadia Reptile, Illawarra Reptile Society, Do Little Farms, PISCES Enterprises and Herp Books Australia.

Abstracts for all of the presentations given during the workshop are included below.

- Alex Mitchell, Melbourne Zoo

Fig. 1. Participants of the 2019 ASMP Reptile TAG Large Varanid Workshop.

Fig. 2. Ian Recchio gives a presentation on varanids at the Los Angeles Zoo.

Fig. 3. Participants tour behind-the-scenes at the Alice Springs Desert Park.

Fig. 4. Tim Jessop gives a presentation on *Varanus komodoensis*.

Fig. 5. Workshop participants photographing a perentie (*Varanus giganteus*).

Komodo Dragon Management and Reproduction at Los Angeles Zoo

IAN RECCHIO
Curator of Amphibians, Reptiles and Fish
Los Angeles Zoo

An overview of breeding and husbandry techniques used at the Los Angeles Zoo, resulting in several successful reproductive events, with emphasis on breeding introductions, incubation/neonate husbandry and overall captive management of a breeding pair of *Varanus komodoensis.*

Successful Blood Collection Technique used for Sex Determination of Incubating *Varanus komodoensis* Eggs at the Los Angeles Zoo

IAN RECCHIO
Curator of Amphibians, Reptiles and Fish
Los Angeles Zoo

A step by step review of a safe technique developed at the Los Angeles Zoo to draw blood from Komodo dragons eggs, to be used in determination of the embryos sex. Discussion of the significance of egg sexing as a tool for squamate management.

Reproduction of the Rare, Frugivorous Monitor, *Varanus olivaceus,* at Los Angeles Zoo

IAN RECCHIO
Curator of Amphibians, Reptiles and Fish
Los Angeles Zoo

Discussion of captive management of *Varanus olivaceus* and several successful reproductive events at Los Angeles Zoo. With emphasis on captive diet adaptations, management and incubation of a sensitive eggs, and neonate husbandry.

Lace Monitor Training - Utilising Positive Reinforcement for Hands-free Husbandry

HANNAH WIGGS
Reptile and Logistic Keeper
Moonlit Sanctuary

Moonlit Sanctuary in collaboration with Ryan Cartlidge (Animal Training Academy) are working towards utilising positive reinforcement training to minimise stress and disturbances, increase welfare and reduce potential hazards for keepers associated with working with animals. This paper intends to take you on a journey about my own shift in perception of an animal labelled as ‘hazardous’, to give insight into her intelligence and capabilities and to challenge ideas surrounding the ‘trainability’ of reptiles.

Keeping Komodos 'Correctly' - Learnings from London and Beyond

RICHARD GIBSON
Head of Life Science
Auckland Zoo

For an ectotherm the climate is everything, and keeping truly tropical large reptiles outside of tropical latitudes requires considerable planning and investment. Failure to replicate these environmental parameters, and meet dietary, reproductive and other behavioural needs of Komodo dragons, can have far-reaching consequences for dragon health and welfare.

Oedipus and the Dragon - or - Understanding Facultative/Accidental Automictic Parthenogenesis

RICHARD GIBSON
Head of Life Science
Auckland Zoo

Asexual reproduction in vertebrates is not as rare as we used to think but it's a complicated process to understand how and why it occurs. When it happens in Komodo dragons, fertility and viability are very low and the offspring are all male - so what's going on?

"Grabbing the Goanna by the Tale" - Management of Lace Monitors and their Role as a 'Charismatic Mega-vert' at Auckland Zoo

SETH GARDEN
Ectotherm Keeper
Auckland Zoo

Zoos often commit huge resources into the design, construction and interpretation of exhibits for select charismatic mega-vertebrates. There can, however, be surprising results when zoos choose to make a feature of less 'popular' species. In 2015 Auckland Zoo chose lace monitors *Varanus varius*, as the focal species for its 'Strangely Beautiful Australia" development, which subsequently opened in 2017. With no other monitor lizards in the country and, at the time, no other collections committing to the species, the zoo invested heavily in the acquisition and establishment of a sizeable group in order to ensure a degree of institutional sustainability. In addition to a stunning 80m^2 exhibit, showcasing these cosmopolitan varanids in a suburban bush setting, dedicated accommodation included a substantial off-exhibit holding and breeding facility. The size and flexibility provided by these combined spaces allowed for manipulation of group size and sex ratios, which in combination with a detailed program of seasonal environmental and dietary variation, weight management and behavioral training, ultimately resulted in the first breeding success in December 2017 - and continued success ever since. The hatching of more than 30 lizards to date has not only secured the species medium-term future in New Zealand collections (now everyone wants them!) but allowed us to meet significant international demand in the AZA and EAZA zoo communities. Four years into the project, the zoo's lace monitor facilities continue to reward the original investment and feedback for the exhibit remains incredibly positive - even from Australians!

Perentie Husbandry - Rectifying Husbandry and Dietary Plans

NEISHA GRAHAM
Senior Reptile Keeper
Oakvale Wildlife Park

Obesity is one of the most commonly reported health issues in captive reptiles. This condition has often led to secondary health implications, with some of the more commonly reported implications being, incomplete or failure to reproduce and premature death. Oakvale Wildlife Park is currently working towards improving the health of two adult Perentie (1.1.0) through veterinary treatment, dietary and husbandry plan adjustments, with the aim to improve their overall wellbeing and decreasing their weight, resulting in healthier animals thriving in the captive environment. Exposure to detrimental husbandry issues throughout their life has resulted in poor overall health including obesity, failure to slough and respiratory infections. Husbandry and treatment plans have been created to address and rectify these problems.

Physical and Behavioural Indicators of the Reproductive Stages of Monitors

DAVID KIRSHNER
Curator of Reptiles
Sydney Zoo

Using photographs and videos the visual indicators of the reproductive stages in the lace monitor, *Varanus varius*, are presented. The lace monitor is the most common monitor species in Australian collections, but as varanids are fairly conservative in their reproductive behaviours (aside from nesting preferences), this species can be used as a model for recognising these indicators when attempting to breed other members of the group.

Nesting Behaviours of Heath Monitors, *Varanus rosenbergi*, in the Sydney Region

DAVID KIRSHNER
Curator of Reptiles
Sydney Zoo

The heath monitor, *Varanus rosenbergi*, is considered to be the most studied of all Australian monitors due to long-term research on Kangaroo Island, but the NSW population is relatively poorly known. Aspects of nesting behaviour in heath monitors in the region of Sydney, NSW, were recorded on camera during opportunistic visits to termite mounds in late summer and early spring over several years. Recorded observations included nest digging and backfilling, evidence of two females nesting in the same termite mound in a single nesting season, nest guarding by females, intra-specific nest marauding by a male *V. rosenbergi*, inter-specific nest marauding by *V. varius*, active nest defence by a female *V. rosenbergi* and hatchling emergence

How to Successfully Breed Australian Varanids in Captivity

BYRON MANNING
Curator of Wildlife
Cleland Wildlife Park

Over the last 20 years, substantial advances have been made in the captive husbandry of reptiles and amphibians. Species that were once considered difficult to keep and breed are now established within many zoo and private collections, in large part because the captive breeding of these animals is occurring more often. For Australian reptiles, the increased success in captive keeping and breeding is a reflection of keepers having a better understanding of reptile biology and reptile requirements in captivity. We are now able to replicate more naturalistic environments in captivity with the use of improved heating, UV lighting, better diets and the availability of other commercial products developed specifically for reptiles. Information is now easier to access. There has been a substantial increase in the number of peer-reviewed papers, dedicated topic magazines and grey literature on the care and breeding of reptiles in captivity. Moreover, people are now able to share knowledge though social media outlets. But simply having a pair of lizards plus all the technology and information available will not produce desired breeding results if it is not all brought together in the right way. I have successfully kept and bred more than 10 species of small-medium and large native varanid species over the past 8 years. I have applied the methods I employ to all the varanid species I have kept. They have been fine-tuned over the years, and tweaked to accommodate the specific requirements of each particular species, but they are successful and do result in an extended breeding period and multiple clutches within that breeding period. This paper will outline what I do to successfully keep and breed small-medium Australian varanid's, focussing on the methods that work across all species. I will also talk about some of the challenges I have encountered over the years, and discuss how I overcame these. Finally, I will give away some of my species-specific secrets (but not all) to demonstrate that, while the varanids are all the same, they are also just that little bit different from each other. And there-in the challenge lies!

An Overview of Komodo Survival Program: Integrative Approaches to Conservation of Komodo Dragons

TIM S. JESSOP[1], ACHMAD ARIEIFIANDY[2], DENI PURWANDANA[2] & CLAUDIO CIOFI[3]

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[2]*Komodo Survival Program, Denpasar 80223, Bali, Indonesia*
[3]*Department of Biology, University of FlorenceVia Madonna del Piano 6 - 50019 Sesto Fiorentino (FI), Italy*

The Komodo dragon, *Varanus komodoensis*, the world's largest lizard is endemic to five islands in southeast Indonesia. The islands of Komodo, Rinca, Nusa Kode and Gili Motang are part of Komodo National Park. On Flores, the fifth and largest island, three nature reserves, Wae Wuul, Wolo Tado and Riung, harbour extant Komodo dragon populations on the west and north coast, respectively. There is a vital need of island-based conservation strategy on managing Komodo dragon population in their current distribution areas, Flores and adjacent islands within the boundary of Komodo National Park. KOMODO SURVIVAL PROGRAM (KSP) is an Indonesian-based non-profit organisation that has the mission to provide sound information on wildlife biology to help devise management and conservation plans for the Komodo dragon and its habitats. This seminar will describe how KSP provides support for the following tasks:

- Acquisition of quantitative data on the biology, ecology, and conservation status of the Komodo dragon, its natural habitat and the biodiversity included in the species' range;
- Development of local expertise for conducting scientific monitoring, management and conservation of Komodo dragon populations, their environment and the terrestrial biological diversity included in their range;
- Development of an easily accessible database of reliable information on general aspects of Komodo dragons' ecology, conservation and management, and of the terrestrial biological diversity included in the species' range;
- Support for the involvement of local communities in wildlife protection and monitoring activities through the development of awareness and sustainable development projects for conservation of their environment and associated natural resources.

Explorations into Komodo Dragon Persistence and some Vital Stats from the Field to Inform Captive Husbandry of Komodo Dragons

TIM S. JESSOP[1], ACHMAD ARIEIFIANDY[2] , DENI PURWANDANA[2] & CLAUDIO CIOFI[3]

[1]*Centre for Integrative Ecology, School of* Life *and Environmental Sciences, Deakin University, Waurn Ponds, Victoria 3220, Australia*

[2]*Komodo Survival Program, Denpasar 80223, Bali, Indonesia*
[3]*Department of Biology, University of FlorenceVia Madonna del Piano 6 - 50019 Sesto Fiorentino (FI), Italy*

This seminar will address two themes:

First, explorations into the persistence of Komodo dragons: The Komodo dragon (*Varanus komodoensis*), the world's largest lizard, arrived in Flores on eastern Indonesia ~ 900,000 years before present. The species subsequently colonized a small number of adjacent islands resulting in an otherwise highly restricted range distribution. Studies of their phylogeography and genome point to differences in demographic history of populations and specialized organismal traits, respectively. However, this information does little to functionally explain how these large lizards have persisted across disparate island environments for millennia. Here I will discuss the roles of key eco-evolutionary processes including phenotypic plasticity, dispersal, intraspecific niche partitioning, ectothermy and predator-prey interactions that appear to be significant in explaining Komodo dragon persistence. As collectively these key processes appear to have allowed Komodo dragons to ameliorate strong spatio-temporal selection, favour local adaptation, and buffer against stochastic processes synonymous with island extinction. Second, I will present an overview of more general Komodo dragon biology including aspects of reproduction, movement ecology, somatic growth and energy requirements. This will be framed with the view of facilitating captive husbandry of Komodo dragons.

Considerations for the Reproductive Management of Varanid Lizards in Captivity: History, Challenges and Evolving Perspectives

ROBERT W. MENDYK
Curator of Herpetology
Audubon Zoo
(remote presentation)

Varanid lizards have been maintained in zoological parks and private collections for nearly two centuries, yet successful reproduction in captivity did not begin to occur until just a few decades ago. Captive breeding success for many species has steadily increased in frequency in recent years as more information has been gained about their biology and captive care. Despite these advances, many challenges associated with their reproductive management still remain. This presentation offers a brief historical overview of efforts to reproduce varanids in captivity over the last century, discusses changing attitudes and perspectives on their husbandry and reproduction over this period, and addresses current challenges that may be impacting reproductive success.

What is Light? How Does the Sun Impact Animals? How and Why we Should Accurately Replicate this in Captivity - Even for 'So-called' Carnivores

JOHN COURTENEY-SMITH
Head of Science and Innovation
Arcadia Reptile
(remote presentation)

Did you know that light is as much a part of amphibian nutrition as water? Understand the importance of heating and how UV-B is converted to usable vitamin D3. Discover how a lamp actually works and how to get the very best out of it. Topics covered include: how the sun provides us with energy; how lamps work, UV, infrared, light meters, LEDs, PAR, PUR, CRI, Kelvin, habitats, 'Light & Shade', MBD, basking and much more.

Video Presentation: Training Program for Komodo Dragon at Perth Zoo

DUNCAN HALIBURTON[1] & KERRY PICKLES[2]
[1]*Senior Technical Officer- Zoology*
Perth Zoo
[2]*Technical Officer, Zoology*
Perth Zoo

Perth Zoo's Komodo Dragon Conditioning Program is based on positive reinforcement operant conditioning principles, and the development of a positive rapport between Technical Officers and Komodo Dragon 'Raja'. The program aims to facilitate co-operative management to support general husbandry and veterinary requirements which results in increased positive experiences for the Komodo dragon. Broader enrichment opportunities and mental and physical fitness are also enhanced, further supporting positive welfare. Perth Zoo's Komodo Dragon exhibit has been converted from housing various mammal species and is retrofitted with appropriate features to accommodate the Komodo Dragon. The video is intended as a training tool for Keeping and veterinary staff involved in Komodo husbandry and care within the exhibit at Perth Zoo, to maintain consistency in the conditioning program and safety when working in the exhibit with the dragon.

Reptile Close Encounters: Developing New Engagement Opportunities for Guests

BORJA REH
Assistant Director of Zoology
Singapore Zoo

Some of the most engaging experiences for visitors in zoos are the encounters with the animal care staff during their daily routine. Animal keepers show strong values and passion that inspire guests to respect and protect wildlife. Such encounters might end up with bonds between the guests and the animals and unforgettable memories, particularly among children. With the above consideration, the Zoology team at Wildlife Reserves Singapore (WRS) was actively involved in the design of new exhibits that encourage such spontaneous encounters. The objective was to change people's perceptions by removing common misconceptions about reptiles. At the same time, enhancing the display value by showing dynamic behaviors in animals that otherwise would remain static. The conceptual idea was to provide the keepers with different opportunities to share their daily work with guests in an unplanned natural way. Front-opening habitats were constructed to allow the keepers to take out animals for engagement and feeding sessions. We also designed it in such that the keepers could decide how much of their work to share depending on the degree of engagement shown by the guests. We selected non-dangerous and easy to handle animals for these encounters including bearded dragons, chameleons, and milk-snakes among others. Therefore, there is no risk involved in the activities. We also built a glass front back of house that allows guests to interact with the keepers. We received four letters of appreciation within the first two months after starting the new Reptile Close Encounter program. Moreover, the herpetology team was granted the WRS Best Experience Innovation award evidencing the success of the program and offering new possibilities for future developments. Many reptiles are among the most threatened species in the world. Yet, not many visitors pay attention to their conservation status and their need for help. Close encounters contribute towards educating and raising awareness about these issues.

Development of a Herpetology Collection Plan to Bring Reptiles Closer to People

BORJA REH
Assistant Director of Zoology
Singapore Zoo

Many zoos in the tropical climate of Southeast Asia are known for their great outdoor reptile exhibits, especially when it comes to the most iconic and bigger reptiles like Komodo dragons, giant tortoises or crocodiles. However, the smaller and more sensitive species of reptiles and amphibians are not as highly represented, mainly because of the bioclimatic necessities of the animals that must be controlled and constant. We implemented a herpetology collection plan including small lizards, frogs, and snakes for the new reptile house at Singapore Zoo. Here, we explain the process behind developing the collection plan, focusing on three key aspects: animal welfare, guest experience, and conservation value of the collection (education value). We designed new exhibits from a technical as well as aesthetical point of view, and the collection of species was selected to achieve an attractive and charismatic display of reptiles and amphibians. Large size exhibits and small animals remain a challenge for the display value of exhibits in zoos, especially when it comes to "motionless" reptiles. We employed the use of mixed species and time-sharing displays to create a three-dimensional vision of the habitats. We planned an animal collection with species that would coexist and filling the three different levels of the exhibit: ground, low rocks and tree branches. We also used invisible barriers between the exhibits to offer a wider view of the habitats. With this approach, we managed to showcase diverse species within a single view. We ensured the compatibility of the species that were mixed by looking at their natural history as well as their individual preferences regarding space usage among others. We performed slow adaptation processes

by using their senses, especially sight and smell to acclimate the species to their new companions. We kept 24-hour close observation during the first weeks to ensure the behavior patterns of the animals remain compatible during the whole day. Those animals showing stress signs were not included on display. The technical features of the exhibits provided the temperature and humidity gradients that are required for the correct development and behavior of the animals. Computer controlled facilities provide artificial misting, hotspots as well as sound enrichment in the habitats where the animals live. We have observed an increase in activity levels of all animals, especially the smaller species since moving to their new exhibits. The feedback from guests is very positive, and people are spending an average of 60% more time in the new reptile house compare to the old one.

Advances in Crocodile Monitor Husbandry and Reproduction

BORJA REH
Assistant Director of Zoology
Singapore Zoo

Crocodile Monitors (*Varanus salvadorii)* are large arboreal lizards found exclusively in the island of Papua New Guinea. Their ecology and behaviour combined with their cryptic nature make them difficult to study in the wild and therefore, very limited literature on their natural history and behaviour is available. Keeping Crocodile Monitors in captivity is a challenge and breeding has only been achieved on a few occasions and never consistently. The difficulties of their captive management are mainly related to physical scoring, compatibility of animals, nest selection, as well as egg incubation. Animals in zoos have historically suffered from different pathologies such as dystocia, and intraspecies aggression which has been observed in all possible gender combinations. To tackle these issues, we compiled and studied information from EAZA and AZA institutions that have managed to breed this species successfully in recent years. The information gathered has provided insightful considerations. This presentation aims to provide recommendations on captive management and reproductive of this remarkable species.

A New Komodo Exhibit for the Australian Reptile Park and an Exhibit-related Injury

JAKE MENEY
Supervisor of Reptiles
Australian Reptile Park

This presentation will cover the newly constructed Komodo Dragon exhibit, the challenges we've faced with it and the changes we've made to it. It will focus on the exhibit related injury in our male and outline the cause, subsequent treatment and recovery

The Life and Times of Toledo Zoo Herpetology

NICK GORDON
Lead Keeper- Herpetology
Toledo Zoo

This three-part presentation will take an in-depth look at the Toledo Zoo's herpetology department from past, present to future. This will highlight the historic Works Progress Administration (WPA) Reptile House built in 1934, the newly renovated Promedica Museum of Natural History and some significant herpetological conservation programs that the Toledo Zoo is involved in.

Komodo Dragons at Australia Zoo

RYAN PILGRIM
Reptile Keeper
Australia Zoo

This presentation will provide a brief overview of Australia Zoos Komodo Dragons. The zoo is currently home to a single Komodo named Indah. Indah is an extraordinary dragon, fit healthy and active with a well natured demeanour. Indah's success in captivity is the product of hard-working keepers ensuring that husbandry standards continue to be improved. I will provide information on current training, enrichment and conditioning techniques which are implemented to maintain Indah's strength, fitness and positive mental state. I will also discuss techniques which allow us to monitor Indah's health, as well as the recent improvements made to the existing Komodo display and future plans for the species at Australia Zoo.

Use of Thermal Imagery to Assess Effectiveness of Heating Reptile Enclosures

ALEX MITCHELL
Senior Keeper- Ectotherms
Melbourne Zoo

The use of Thermal Imagery, to assess the thermal properties of reptile exhibits is a non-invasive approach to allow keepers to gain a much better and visual understanding of the effectiveness of artificial heating and of the thermoregulatory behaviours of captive reptiles. This allows keepers to ensure that the heat sources provided to reptiles in a captive environment are working in the manner in which they were intended. Thermal Imaging Cameras can be an additional tool used by Herp Keepers in the day to day servicing and monitoring of exhibit heating.

Past, Present and Future of Komodo Dragon ASMP Program

CHRIS DRYBURGH
Senior Reptile Keeper
Taronga Zoo

Chris will cover the past, present and future of the Komodo dragon ASMP program, and will outline the background of previously held dragons within our region, outline the current state of the program, and cover the future goals of the ASMP Komodo dragon program- primarily to have the ability to breed to supply the region with a current group of Komodo dragons being acquired from Prague Zoo, and assist in the ongoing in-situ work of the Komodo Survival Program.

Behind the Scenes- Filming Natural History Documentaries with Perentie and Thorny Devil

REX NEINDORF
Director
Alice Springs Reptile Centre

Rex will take you behind the scenes of some of the greatest natural history documentaries of all time involving reptiles. The vast majority of Thorny Devil and Perentie sequences ever filmed involved animals housed in the collection of the Alice Springs Reptile Centre. Sequences involving mating, egg deposition, hatching, feeding, male combat, predation, predator avoidance and general natural history have all been filmed with reptiles from the Reptile Centre. Reptile Centre animals have featured in advertisements, major motion pictures and numerous natural history documentaries. Film crews from around the world including England, France, Japan, Canada and the USA have filmed in Alice Springs. Rex has seen all the major technological innovations over many years starting with standard film, IMAX, Digital, HD, 4K and now 8K.

Spatial Ecology and Behavior of Wild Perentie (*Varanus giganteus)*

KARI SOENNICHSEN

Field Technician
Project Perentie

The perentie is an iconic animal of the Outback, yet as a result of the species' cryptic nature, very little is known about the ecology and behavior of this lizard in the wild. Understanding how perenties are adapted to their dry, desert environments will not only help inform us about their role within the ecosystem but also offer insight on requirements for captive animals. In order to learn more about the species, a collaborative effort between Macquarie University, University of South Florida- St. Petersburg, Northern Territory Flora and Fauna Department, and Tennessee Tech has established Project Perentie. The project involves a multi-year radio-telemetry study on approximately 15 wild perenties at Curtin Springs, Northern Territory. Preliminary data has revealed substantial differences between large males and smaller animals, particularly with respect to behavior, home range size, and habitat use. With increased funding and the employment of drone-assisted radio-telemetry or GPS transmitters, we aim to be able to uncover even more previously undocumented aspects of this charismatic species' wild ecology.

ARTICLES

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Report on the Awareness Workshops "Perceptions of Wildlife Conservation of Today's Youth in West Bengal, India, with a Focus on Monitor Lizards"

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Abstract - Several awareness workshops were jointly organized by the Environment, Agriculture and Education Society (EAES) along with the International Union for Conservation of Nature and Natural Resources (IUCN) Species Survival Commission's (SSC) Monitor Lizard Specialist Group (MLSG) in five districts of West Bengal, India from 29 July to 2 August 2019. The main objective of the workshops was to create widespread awareness among the local youth regarding the conservation, utilization and illegal trade of wildlife, with a special focus on monitor lizards in India. In total, more than 1,000 students aged 12 to 24 participated in the workshops.

Background to the Awareness Workshops

The traditional hunting practices and self-sufficiency of a community with food play an important role in the coexistence of man and wildlife (Ormsby & Bhagwat, 2010; Bhattacharya & Koch, 2018). Since ancient times, local communities and ethnic groups across the world have largely depended on wildlife for diverse utilization purposes such as consumption, cultural ritualistic practices and traditional medicine (Chakravorty *et al*., 2011; Bhupathy *et al*., 2013; Kendie *et al*., 2018). Likewise, the use of monitor lizards in India dates back centuries (Das, 1989), if not millennia. There are various traditional uses of monitor lizards' parts in southern India (Das, 1989; Auffenberg, 1989, 1994), some of which include the consumption of monitor eggs as a delicacy and various uses of monitor meat. Oil obtained from the fat bodies of monitors is used for eye treatment. Additionally, ancient country doctors, or "hakims" as they were commonly called, used parts of monitors (*e.g.*, *Varanus griseus*) as a source of medicine.

Today, in many parts of the Indian subcontinent, monitor lizard meat is widely consumed and the body parts find applications in diverse traditional and medicinal purposes (Chakravorty *et al*., 2011; Choudhury & Choudhury, 2019). With the effects of modernization, commercialized food sources and medicines have become more available and accessible to mankind than ever before (Pelto & Pelto, 1983; Mina *et al*., 2007). However, in spite of these conditions, illegal use of wildlife in several parts of India still persists (Chakravorty *et al*., 2011; Bhupathy *et al*., 2013; Bhattacharya & Koch, 2018). Thus, it is important to address and identify the social values and needs of a community to deal with such situations (Madden & McQuinn, 2014).

Four species of monitor lizard are native to India, *i.e*., *Varanus bengalensis*, *V. salvator*, *V. flavescens* and *V. griseus,* and all are protected and listed under Schedule I, Part II of The Wildlife (Protection) Act of India, 1972, Government of India (Das, 1989; Koch *et al*., 2013). According to the International Union for Conservation of Nature and Natural Resources' (IUCN) Red List, the current conservation status of *V. bengalensis*, *V. salvator* and *V. flavescens* is considered to be of "Least Concern". While the former two species were assessed in 2009, the latter was assessed in 1996. The conservation status of *V. griseus* is pending, and reassessments of the former three species are currently being conducted. Moreover, according to the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), *V. bengalensis, V. flavescens* and *V. griseus* are listed in Appendix I (thus, prohibiting all commercial trade), whereas *V. salvator* is listed in Appendix II. In West Bengal, three species of monitor lizards occur: *V. bengalensis*, *V. salvator*, and *V. flavescens* (Chatterjee & Bhattacharyya, 2015).

A series of awareness workshops entitled "*Perceptions of Wildlife Conservation of Today's Youth in West Bengal, India, with a Focus on Monitor Lizards*" were jointly organized by the Environment, Agriculture, and Education Society (EAES) along with the IUCN Species Survival Commission's (SSC) Monitor Lizard Specialist Group (MLSG) in five districts of West Bengal, eastern India. The main aim of the workshops was to address the key challenges responsible for the exploitation of monitor lizards in India to the younger generations and to raise awareness among them to influence, motivate and improve their knowledge of these particular reptile species. The primary objectives of the workshops were to:

(a) gain an understanding of the perceptions of younger generations regarding the rapid encroachment and fragmentation of forests and wetlands in India

(b) gain an understanding of their attitudes about the presence, interactions, and conflicts related to monitor lizards found in their areas

(c) understand and document their perceptions of the extent of traditional and cultural utilization of monitor lizards and their derivatives

(d) gain insights into the perceptions about the illegal trade of monitor products such as "hatha jodi" (*i.e*., hemipenes) (D'Cruze *et al*., 2018; Sharma *et al.*, 2019)

(e) provide a clear picture about the ecological role of monitor lizards and why they need to be conserved

(f) explain the importance of marshlands, wetlands, and forest fringes for the preservation of biodiversity

(g) spread awareness about the Wildlife (Protection) Act of India, 1972, and discuss the protection status and penalties related to all four species of monitor lizards found in India

(h) encourage and motivate the youth to be responsible and stand against the exploitation of monitor lizards along with other wildlife in their area

Threats to Monitor Lizards in India

Habitat loss and fragmentation are considered to be the greatest threats to wildlife across the world (Eigenbrod *et al*., 2008; Sodhi *et al*., 2010). In different parts of India, there is a rapid loss of wetlands for agricultural land conversions, direct deforestation and hydrological alterations, among others (Foote *et al*., 1996). There is also a constant degradation of mangrove forests along the eastern coast of India, which also includes the Sundarbans, a UNESCO world heritage site in West Bengal and common habitat for *V. salvator* (Chatterjee & Bhattacharyya, 2015; Chaudhuri *et al*., 2015).

Apart from the various aspects of their utilization by humans, monitor lizards are often considered to be pests and are known to cause conflicts with poultry farmers (Choudhury & Choudhury, 2019). In addition, illegal hunting festivals are celebrated in different parts of West Bengal throughout the year (Fig. 1). These traditional hunting activities pose a severe threat to local populations of monitor lizards and other wildlife and might be responsible for their decline in several parts of the state (Bhattacharya, pers. obs.). These hunting festivals, commonly known as "shikarutsab" in Bengali ("shikar" refers to hunting and "utsab" means festival), are cultural traditions that are passed on from one generation to the next. Young children also participate in these festivals. Although all four monitor lizard species are protected in India (see above), these hunting traditions still persist in the outskirts of West Bengal and among other areas, due to the lack of awareness campaigns among the local communities and more relaxed law enforcement.

Fig. 1. A boy with his monitor lizard kills; four specimens of *V. flavescens* during a hunting festival on the outskirts of West Bengal. Photographed by **Tanmoy Ghosh**.

Methodology and Schedule of the Workshops

The workshops were conducted in five districts of West Bengal, namely Hooghly, Bankura, Purulia, Birbhum, and Howrah from 29 July to 2 August 2019 (Fig. 2). We aimed for one school and one college in each district except for Birbhum, where we conducted the workshop at one college. Participating school students were from sixth through twelfth grades (roughly 12 to 18 years of age) and college students were from Bachelor's and Master's degree programs (roughly 18 to 24 years-old). The duration of the workshops was one and a half hours, and each workshop was divided into five thematic parts. During the first part of the workshop, questionnaires with 20 multiple-choice questions were distributed to the students. The questions were related to the general perceptions of the audience about biodiversity, wildlife, habitat destruction, filling in wetlands and marshlands, and general ideas about monitor lizards –their presence, interactions, conflicts, utilization related to traditional or cultural practices, and their illegal exploitation for the international trade (see above). After a stipulated time interval of 10 to 15 minutes the questionnaires were collected, so as to obtain unbiased perspectives of the participants prior to the lecture. The next part of the workshop included a Power Point presentation of approximately 40 minutes given by the first author, which addressed the following topics:

(a) general description of biodiversity and wildlife conservation

(b) importance of wetlands and threats by destruction

Fig. 2. The brochure of the awareness workshops.

(c) a brief description of monitor lizards, their geographical distribution and importance in the ecosystems, as well as their protection status in India

(d) local and commercial (international) use of monitor lizards and their derivatives

(e) the illegal trade of wildlife with a special focus on the commercialization of trade in "hatha jodi" in India

(f) brief introduction of the IUCN Red List and The Wildlife (Protection) Act of India, 1972

(g) brief description of the IUCN SSC Monitor Lizard Specialist Group (MLSG) and their mission

(h) conclusion of the presentation by addressing the plight of Indian monitor lizards, if the unsustainable utilization and the illegal trade of the species continues

The third part of the workshops was an interactive session with the students, addressing their questions and comments on the questionnaire and presentation. The fourth part was to distribute a follow-up questionnaire to the students in order to compare and determine if their perceptions towards wildlife conservation and monitor lizards might have changed from the workshops. The fifth part included the distribution of participatory certificates to motivate the students to participate in the workshops and fill up the questionnaires.

Outcomes of the Workshops

More than 1,000 students participated in the workshops from the five districts of West Bengal (Figs. 3–6). Apart from spreading awareness among the youth regarding the conservation of monitor lizards, the workshops were designed to collect baseline data about the social perceptions of the young generation towards monitor lizards found in their region. We aimed to obtain unbiased data from the participants; hence, two different questionnaires were distributed–one prior to the workshop and one at the end to gain an idea about the influence and effectiveness of the workshops on the youth.

While the detailed statistical analysis of the questionnaires will be published elsewhere, as one main outcome of the workshops, it turned out that the majority of the young participants were unaware of the Wildlife (Protection) Act of India and the protection status of monitor lizards in their country. This broad unawareness among the Indian population may explain the wide exploitation and utilization aspects of the species. The responses of the participants were mostly positive after the workshops and we were approached with several interesting questions regarding the traditional and cultural utilization practices and misconceptions related to monitor lizards in different communities across each district. It is noteworthy to mention that traditional beliefs of the utilization of monitor lizards are not equal across all the communities, but gradually differ from

Fig. 3. A glimpse during the workshop at Bamnia Vivekananda Vidyapeeth High School after the distribution of the first questionnaire.

Fig. 4. Distribution of feedback forms to the participants of Sonamukhi College by the team members of EAES after the interactive session.

one district to another based on their ancient roots. For example, in Birbhum District oil obtained from the fat of monitors is used for the treatment of joint pains, whereas in Purulia District their claws and meat are used for traditional medicinal purposes.

Conclusions of the Workshops

It is a well-known fact that the utilization of monitor lizard parts has ancient roots in South Asia (Das, 1989; Auffenberg, 1989, 1994). Hence, besides focusing only on the strict law enforcement and compensation to poultry farmers for losses by monitor lizards, it is equally important to identify and address the psychological attitudes and needs of a community that are responsible for these social conflicts (Madden & McQuinn, 2014).

Fig. 5. The first author during the presentation session at Gangadharpur High School of Howrah District.

Thus, it is essential to focus on the complexity of the social, psychological, and systematic root causes (Madden & McQuinn, 2014) that have driven the utilization of monitor lizards in India up until today. Moreover, in most cases, the extent of exploitation is unknown and commonly unreported. This situation can significantly affect the population dynamics of monitor lizards and might also result in local extirpations of these species.

Younger generations play a significant role in shaping future society and the environment. Hence, it is crucial to educate and thereby motivate and influence them with logical reasoning and ethical responsibility on the current situation and consequently change their mindsets to bring about positive differences in their communities. Therefore, to improve the current situation, it is highly recommended to conduct similar workshops throughout local village communities across different parts of India especially for the younger generation along with other groups of audiences (*i.e*., varied age groups and

Fig .6. All participants after the completion of a successful workshop at Bamnia Vivekananda Vidyapeeth High School.

occupations). Additionally, field studies should also be conducted to evaluate the impact of domestic use on Indian monitor lizard populations.

Acknowledgments - For their contributions and support during the workshops we thank Indrani Bhattacharya, Kallol Bhattacharya, Jaspal Singh, Ram Das, Urvashi Goswami, and Shuvra Kanti Sinha. We are grateful to Tanmoy Ghosh for providing a photograph demonstrating illegal hunting of monitor lizards in West Bengal. In addition, we are thankful to the authorities of Sree Narayan Institution (HS) and Bejoy Narayan Mahavidyalaya of Hooghly District, Dhulai R.K.M Vidyamandir, Sonamukhi and Sonamukhi College of Bankura District, Bamnia Vivekanada Vidyapeeth and Acchruram Memorial College of Purulia District, Suri Vidyasagar College of Birbhum District, Gangadharpur High School and Gangadharpur Shikshan Mandir of Howrah District for supporting and encouraging us to arrange the workshops at the respective educational institutes.

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Received: 28 October 2019; Accepted: 20 December 2019

Biawak, 13(2), pp. 101–102

New Locality Record of the Yellow Monitor Lizard (*Varanus flavescens*, Hardwicke and Gray, 1827) in Dhaka, Bangladesh

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Abstract - A new locality for the yellow monitor lizard (*Varanus flavescens*) in Dhaka Division, and a range extension for Dhaka District, Bangladesh is described.

The yellow monitor lizard (*Varanus flavescens* Hardwicke and Gray, 1827) is one of three monitor lizard species in Bangladesh (Islam, 2009). The distribution of *V. flavescens* includes floodplains of the Indus, Ganges, and Brahmaputra Rivers in Pakistan, northern India, Nepal, Bhutan and Bangladesh (Auffenberg *et al*., 1989; Visser, 2004; Islam 2009). Although the species is widely distributed in Bangladesh, it is considered to be a "Near Threatened" species nationally (IUCN, 2015). The species is highly secretive and has proven to be difficult to locate (Visser, 2004). A breeding pair of *V. flavescens* was found at Chandpur village of Netrokona District in Dhaka Division (Reza & Sourav 2010), and this species has also been found in Sylhet and Chittagong Divisions (Islam, 2009). However, very few locations are known due to its unclear distribution within the country and because very little published information is available on the species in Bangladesh.

On the morning of 8 March 2019 at 1033 h, we observed an adult *V. flavescens* in the wetlands at Mirpara village (23°43′38.47″ N, 90°29′10.33″ E) in Dhaka (Fig. 1.). The area consists of a series of wetlands connected to one another by various channels that form a continuous water body that persists throughout the

Fig. 1. Map depicting location where *Varanus flavescens* was spotted in Bangladesh.

Figs. 2 & 3. *Varanus flavescens* in its natural habitat at Mirpara in Dhaka.

year. This area expands into a vast water body with dense aquatic vegetation during the monsoon months. The *V. flavescens* was encountered swimming in the water at the time of our observation (Figs. 2 & 3). The nearest sighting record for the species at Chandpur village (24º57′48″ N, 90º52′21″ E) in Netrokona District was approximately about 142 km north of the current location in Dhaka Division. This account represents a range extension for *V. flavescens* in Dhaka District and a new confirmed locality for Dhaka Division.

Compared to other parts of the country, food for *V. flavescens* is abundant in wetland areas. Over the last decade, the habitats of monitor lizards in Bangladesh have become severely fragmented due to anthropogenic pressures. This report contributes valuable new information on the geographic distribution of *V. flavescens* that can help aid its protection and conservation initiatives in Bangladesh.

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Received: 29 June 2019; Accepted: 8 October 2019

Biawak, 13(2), pp. 103–106

Pododermatitis Surgical Intervention in a Savannah Monitor (*Varanus exanthematicus*)

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Abstract - A five-year-old *Varanus exanthematicus* weighing 3.4 kg was presented with a solid mass on the palmar surface of its rear left foot. During clinical examination, the monitor had gait movement abnormalities, and radiography revealed the mass was radiopaque. Fine-needle aspiration cytology of the mass revealed some cocci-shaped bacteria. Pododermatitis with an encapsulated abscess was diagnosed after both diagnostic methods were performed. Surgery was performed with the lizard under general anesthesia. Fluid therapy, antibiotics, NSAID and topical ointment was administered post-surgery. The wound healed up well and no further gait abnormalities were noticed two weeks post-surgery. Suture materials were removed six weeks post-surgery.

Introduction

The savannah monitor lizard (*Varanus exanthematicus*) is one of the most popular monitor species kept among reptile keepers (Bennett, 2000; Pare, 2006). Some captive breeding of this species has occurred in private and zoo collections, but most are still collected from the wild to supply the strong demand for the species among collectors (Bennett, 2000; Coiro, 2007). Pododermatitis has been observed in large lizards such as varanids and iguanas, chelonians (Scheelings & Hellebuyck, 2019), chameleons (Schmidt *et al*., 2012), and crocodiles (Emikpe *et al*., 2016). Husbandry-related issues are often the cause of these problems (Scheelings & Hellebuyck, 2019), and if left untreated, osteomyelitis may develop.

Case Report

A five-year-old *V. exanthematicus* weighing 3.4 kg was presented with a mass on the rear left foot that had been growing progressively for the past month. The owner mentioned that a sharp edge was found in the enclosure and suspected that this caused the wound which led to the mass. No changes in appetite were noticed. The animal's body score was normal (3/5). During visual inspection, the monitor showed signs of discomfort in the rear extremity while moving, and during palpation. Physical examination revealed a solid mass on the foot and an ulcerative wound was found at the bottom of the wound (Fig. 1).

Radiographic imaging was performed with the

Fig. 1. Inflammation found on the rear left foot. Arrow shows the encrusted area on the distal side of the foot.

Fig. 2. Radiographic image of the rear left limb.

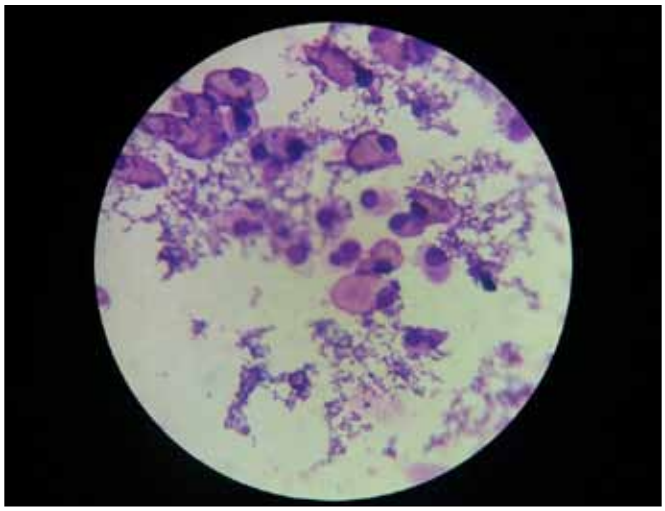

Fig. 3. Diff-Quik staining of the FNA cytology revealing high numbers of heterophil and cocci-shaped bacteria.

monitor in dorsal recumbency. Results showed that the mass was radiopaque (Fig. 2). Tissue aspiration cytology using fine needle aspiration (FNA) directly from the external surface of the mass was performed without anesthesia and with a 23-gauge needle on a 5 mL syringe. The needle was repositioned in several locations with negative pressure (Redrobe & MacDonald, 1999; Alleman & Kupprion, 2007). Aspiration was expelled on a microscopic slide and Diff-Quik staining was used for cytological study. Cytology revealed heterophils, red blood cells and some coccus shaped bacteria (Fig. 3). Cytology also showed some cocci shaped bacteria. Pododermatitis with abscessation was diagnosed based on the results of these techniques.

The *V. exanthematicus* was fasted for 72 hours prior to surgery. The monitor was manually restrained with a gentle, but firm grip on the neck and the hind leg was restrained together with the tail. Acepromazine (15 mg/mL with a dose of 0.1 mg/kg [0.02 mL]) and Ketamine (100 mg/mL with a dose of 30 mg/kg [1 mL]) were injected intramuscularly into both forelimbs separately. Induction took about 25 minutes for the animal to show no righting response. The monitor was then positioned in ventral recumbency, and an endotracheal tube was placed using a sterile 60 drops/mL infusion line. Isoflurane was induced at 4% and maintained at 2%. A fetal Doppler was used to evaluate the heart rate. The monitor was then placed in dorsal recumbency and the infected foot was prepared on a sterile drape. The surgical site was cleaned with diluted chlorhexidine gluconate 4%, and alcohol was applied to the area for sterilization. An incision was performed on the palmar mass, revealing multiple abscesses. All encapsulated abscesses were manually removed with toothed forceps (Fig. 4). Diluted hydrogen peroxide of 1% was then flushed into the surgical site. Saline (physiologic 0.9% sodium chloride) was then flushed into the wound to clear out the hydrogen peroxide. Extra skin was removed before sutures were applied. Absorbable polypropylene 3-0 suture material was used with simple interrupted sutures (Fig. 5). The area was flushed again with saline before topical antibiotic Bioplacenton® ointment (neomycin sulfate) was applied to the wound. Gauze was then applied to the surgical site and wrapped with plaster to minimize infection and gait movements. Enrofloxacin (50 mg/mL with the dose of 10 mg/kg [0.68 mL]) and meloxicam (5 mg/mL with the dose of 0.2 mg/kg [0.13 mL]) were both administered intramuscularly into each forelimb.

Post-surgery treatment included follow-up application of the topical antibiotic ointment, antibiotic injections, NSAID injection and fluid therapy. Enrofloxacin (50 mg/mL at 10 mg/kg) was given daily for seven days and meloxicam (5 mg/mL with a dose of 0.1 mg/kg [taper down dose]) was given every other day for three treatments. Fluids (sodium chloride 0.9%) were administered at 20 mL/kg with a butterfly catheter into the coelomic cavity. Suture material was removed after about six weeks post-surgery.

Discussion

Body condition is a basic consideration of veterinary health assessments. A scoring system of 1 to 5 can be

Fig. 4. Encapsulated abscesses removed from the infected foot.

Fig. 5. Post-surgical sutures.

a useful subjective method, with 1 assigned to animals that are very thin and 5 representing obese individuals (Divers, 2019). The *V. exanthematicus* presented in this case had a normal body score (3/5) based on the normal amount of fat and muscularity around the tail, pelvis and hind legs. The owner reported no changes in the monitor's appetite, which has also been recorded in some other cases of reptiles with abscesses (Jiang *et al*., 2019). The mucosa membrane was pink indicating the monitor was well-hydrated. Abscesses in reptiles are usually detected by the presence of large, swollen or hard masses (Harkewicz, 2001); yet, inflammatory exudates are usually firm in reptiles, indicating neoplasia as a differential diagnosis (Divers & Garner, 2003). The lesion on the distal side of the lump was dried and encrusted, revealing a former puncture wound which could have been the point of entry for the infection. Radiography revealed no bone pathology.

Inflammatory lesions might have decreased pain sensation (Harr & Romagnano, 2015) and present high numbers of heterophils (Alleman & Kupprion, 2007). Abscess treatments in reptiles are best approached with a puncture or surgical removal of the whole infection, continued with antiseptic and antibiotic treatment (Alworth *et* al., 2011; Chaprazov *et al*., 2013). Meloxicam was administered for anti-inflammatory and post-surgery pain management (Rockwell & Mitchell, 2019). Because reptiles have a renal portal system, drugs given intramuscularly are best administered in the cranial half of the body (Mader, 1998); however, fluids can be given intra-coelomically.

Debridement of the wound can stimulate the healing process (Mitchell & Diaz-Figueroa, 2004). Topical antibiotic was given daily to limit opportunistic infections and facilitate wound healing (Fig. 6). During post-surgery, the monitor was placed in a simple tub with clean newspaper as substrate to avoid other infections and to keep the wound area clean. The monitor had a good feeding response two days after surgery, and suture material was removed six weeks post-surgery (Alworth

Fig. 6. Wound seven days after surgical intervention.

et al., 2011; Kubiak, 2019). Inspection after six months showed no reoccurrence.

Acknowledgments - I would like to thank the editorial board of *Biawak* and two anonymous reviewers for reviewing this manuscript. I would also like to thank Danny Gorman, Donald R Wells, Tuti and all those that were involved in this case.

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Received: 20 September 2019; Accepted: 19 December 2019

Biawak, 13(2), pp. 107–108

In Situ Copulation and Intersexual Den Sharing in *Varanus albigularis albigularis* (Daudin, 1802), Eastern Cape, South Africa

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Abstract – An observation of in situ copulation and courtship in *Varanus albigularis albigularis* from the coastal regions of the Eastern Cape, South Africa is described. The unusual behavior of the two individuals sharing a den post-copulation is also described.

Introduction

The white-throated monitor (*Varanus albigularis albigularis*) is a large, diurnal and terrestrial lizard that is widely distributed predominantly throughout savanna, woodland and arid habitats of southern and east Africa, and absent from the far southwestern region of the continent (Alexander, 2014; Spawls *et al*., 2018). Copulation in *V. a. albigularis* occurs from late August to mid-November, with egg-laying taking place around 2-3 weeks after mating (Phillips, 1995). Despite the species' abundance and broad distribution, copulation is rarely observed in the wild due to its shy nature (Branch, 1998). Reported herein is an observation of copulation in *V. a. albigularis* and intersexual den sharing which took place on 1 September 2018 northeast of Port Elizabeth (33°38′55″ S; 25°35′29″ E), Eastern Cape, South Africa.

Observations

On 1 September 2018, two adult *V. a. albigularis* were observed locked in copulation within Coega Bontveld thicket, the dominant vegetation type for the region (Musina & Rutherford, 2006). The individuals were first noticed at 1351 h and observed until 1415 h. The environmental conditions during the observation consisted of a constant ambient temperature of 21 °C, low wind speed and high cloud cover; due to a lack of equipment on hand, no additional climate data were collected. This area receives bimodal rainfall with maximum rainfall occurring in March and October.

Upon recognizing the mating pair, the individuals were observed and photographed from a further distance to minimize disturbance. It was noted that the pair became aware of the observer's presence and initially ceased copulation; after five minutes and with the observer at a distance of ca. 20 m away, courtship and then copulation resumed for an additional 14 minutes. Copulation consisted of slow lateral movements of the upper body and head of the male together with a sideways motion of the tail, while the female laid motionless (Fig. 1). At 1410 h, the female (ca. 70 cm in snout-vent length [SVL]) then removed herself from beneath the smaller male (ca. 50 cm SVL) and retreated towards a north-facing burrow within a calcareous ridge roughly 6 m from the mating location (Figs. 2 & 3). Shortly

Fig. 1. *Varanus albigularis albigularis* in courtship; Male (top) and female (bottom) .

Fig. 2. Female *V. a. albigularis* moving after copulation towards den site.

Fig. 3. Den site which both male and female entered into after copulation.

thereafter, the male followed in the same direction and subsequently entered into the same burrow occupied by the female, which was when observations ceased.

While it is known that male *V. a. albigularis* will usually roam over a large range to mate with multiple females (Phillips, 1995), observations of den sharing between mates has not been reported. It is plausible that the den sharing behavior by both sexes was due to disturbance from the observer, where the behavior observed may not be typical of the species.

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Received: 30 April 2019; Accepted 7 December 2019

Biawak, 13(2), pp. 109–114

An Annotated Bibliography of Captive Reproduction in Monitor Lizards (Varanidae: *Varanus*). Part IV. *Papusaurus* and *Psammosaurus*

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Abstract: Popular in zoos and private collections, monitor lizards have been maintained in captivity for nearly two centuries. During this time, but especially over the past three decades, a voluminous body of publications has brought to light important details and perspectives that have helped advance their captive husbandry and reproductive management. This bibliography presents an annotated compilation of publications pertaining strictly to the captive reproduction of two very different species of monitor lizard, *Varanus salvadorii* (subgenus *Papusaurus*) and *V. griseus* (subgenus *Psammosaurus*). It is intended to serve as a guide for zoos and private herpetoculturists looking to expand their knowledge and familiarity with this group and introduce readers to different perspectives on their management and reproduction in captivity.

Introduction

Monitor lizards have a long and fascinating history of being maintained in captivity that dates back to at least the early 19th Century. Some of the earliest published accounts of monitor lizards in captive collections reference animals held in European menageries and zoological gardens (Cox, 1831; Knight, 1867; Mitchell, 1852; Sclater, 1877), although private keepers also maintained representatives of this group during this period (Bateman, 1897; Lachman, 1899; von Fischer, 1884). Alfred "Gogga" Brown was probably the first individual to genuinely attempt to reproduce monitor lizards in captivity in the late 1800s (Branch, 1991). Although he received hundreds of eggs (from 33 clutches) from a large group of more than 40 captive *Varanus albigularis* he maintained outdoors in South Africa, he was unsuccessful in hatching any live offspring (Branch, 1991). Eggs had also been received but not hatched by other keepers around this time (*e.g.*, Thilenius, 1898); these eggs were usually scattered by the females who clearly did not have appropriate conditions available for nesting (Branch, 1992; Thilenius, 1898). A poor understanding of monitor lizard biology and husbandry and reptile egg incubation undoubtedly prohibited successful captive breeding from taking place for many decades. This was especially apparent in a 1967 report by Osman (1967), who, while discussing a clutch of *V. komodoensis* eggs that were scattered across the ground of the enclosure rather than buried, suspected that the eggs were to be later buried in the sand by the female after they had been left out in the sun for the shells to

harden.

The first documented record of successful captive breeding of a monitor lizard occurred with *V. komodoensis* in 1941 (de Jong, 1944). Unknown to their caretakers, a pair of adults maintained at the Batavia Zoo since 1938 secretly nested a clutch of eggs in their exhibit which unexpectedly hatched several months later, much to the zoo's surprise. The next documented case of successful captive reproduction in monitor lizards did not occur until 1962, when a wild-caught gravid *V. albigularis* produced a clutch of eggs shortly after arriving at the San Diego Zoo, which resulted in a single hatchling (Staedeli, 1962). Several additional species were successfully bred for the first time in the 1970s (Horn, 1978; Horn & Visser, 1989), with more species hatched in the 1980s (*e.g*., Bredl & Horn, 1987; Bröer & Horn, 1985; Eidenmüller, 1986; Eidenmüller & Horn, 1985; Horn & Petters, 1982; Horn & Visser, 1989; Irwin, 1996; Stirnberg & Horn, 1981). From the 1990s onward, monitor lizard husbandry continued to advance rapidly, to the point where at least 53 species have now been successfully reproduced in captivity (Horn & Visser, 1997; Eidenmüller, 2007; Husband & Bonnett, 2009; Brown, 2012).

In previous bibliographic installments, I have focused on the *Varanus* subgenera *Odatria*, *Empagusia*, *Phillipinosaurus*, *Soterosaurus* and the *V. prasinus* complex (subgenus *Hapturosaurus*) (Mendyk, 2015, 2016, 2017, 2018). In this account, the focus is directed towards *V. salvadorii* of the monotypic subgenus *Papusaurus*, and *V. griseus* of the subgenus *Psammosaurus*. Although extremely different from one another in terms of ecology, behavior, body size and morphology, both species have seen marginal reproductive success in captivity. Bayless (1996) prepared an earlier bibliography on *V. salvadorii* for which there were very few publications on the captive husbandry of the species at the time, and far fewer accounts discussing reproductive aspects. Although eggs have been received from captive *V. griseus* as early as the 1890s (Anonymous. 1892; Thilenius, 1898), successful reproduction did not occur for close to a century later (Perry *et al*., 1993), and the species remains rare in captive collections outside of its natural range.

The following bibliography, which represents a continuation of what will be several installments on the captive breeding of monitor lizards, focuses chiefly on *V. salvadorii* and *V. griseus*. Similar works that address other subgenera are forthcoming.

Using this Bibliography

This bibliography covers all aspects of captive reproduction including both successful and unsuccessful attempts. It is largely intended to serve as a resource for zoo professionals and private herpetoculturists working with these species in captivity, but may also prove valuable to conservation biologists, ecologists, veterinarians and general enthusiasts seeking to gain familiarity with existing literature on the reproductive biology of monitor lizards. Species covered in this bibliography are organized alphabetically, with annotations describing the nature and content of each work appearing inside brackets after each reference.

While best efforts were made to document all known publications relevant to the reproduction of these species in captivity, I recognize the possibility and likelihood that some publications may have been missed. Given that bibliographies are perpetual works in progress, I welcome and encourage feedback on publications missing from this bibliography and new accounts as they are published so that they can be added to an updated version of this document in the future.

Acknowledgments – This bibliographic series is dedicated to the late Mark K. Bayless, whose many contributions to the study of monitor lizards have helped advance the fields of monitor biology and captive husbandry, inspire a new generation of enthusiasts, and stimulate new research on this group, including the present bibliography. I am indebted to Kristen Bullard, Richard Green, Michael Hardy, and Polly Lasker of the Smithsonian Institution Libraries for their assistance with sourcing obscure literature, and would also like to thank Ben Aller for allowing access to Mark Bayless's former personal library of monitor literature. Borja Reh and David Tan generously provided photographic material.

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Psammosaurus

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Received: 18 October 2019; Accepted: 2 December 2019

Biawak, 13(2), pp. 115–118

Translation of the article: Zima, Yu.A. 2016. On the toxicity of the desert monitor (*Varanus griseus*) bite. Selevinia 24: 162-163. [In Russian]
Translated by the author

On the Toxicity of the Bite of the Caspian Desert Monitor Lizard (*Varanus griseus caspius*)

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To date, the question of the toxicity of the bite of the gray or desert monitor lizard (*Varanus griseus*) remains open. According to Auffenberg (1986), the bite of the desert monitor lizard does not bear any consequences except for the wounds themselves. But more than 40 years ago, experiments by Gorelov (1971) on the injection of monitor lizards' saliva of the Caspian subspecies into small birds and rodents led to immediate paralysis of the latter. Cases of bites by the desert monitor lizard are rarely mentioned in the literature and information about their consequences is scarce and contradictory. Intoxication by the saliva of the desert monitor was described by Sopiev *et al*. (1987). According to their data, the bitten person, whom the monitor lizard held on to for one minute with its jaws, was observed to suffer dizziness, muscle pain, accelerated heartbeat, and complicated breathing. All these symptoms disappeared after 24 hours. This indicates that the saliva of varanids contains venom which has paralyzing properties, and the difference in opinions about the toxicological effects of the bite (Auffenberg, 1986; Gorelov, 1971; Sopiyev *et al*., 1987) is apparently based on the fact that the bite itself can be either with the application of venom through "chewing" movements with the jaws and the flow of poison into the wound, or as simply cutting or tearing the prey without introducing venom to the tissue.

I managed to gather material on this issue while working in the Kyzyl Kum Desert of southern Kazakhstan. In 2015 and 2016, there occurred three bites by adult monitor lizards (*V. griseus caspius*; Fig. 1) to three different people. The first two bites (to the hand and to the finger) turned out to be rather quick (without holding), the result of which was only lacerations, and no symptoms of envenomation were noted.

In the third case, in September 2016, the author

Fig. 1. *Varanus griseus caspius*; the species resonsible for the bite.

Fig. 2. Wound immediately after bite from a *Varanus griseus caspius*.

herself was "lucky" to experience a bite to her hand by a sub-adult monitor lizard (Fig. 2), which lasted longer and had toxicological consequences. The bite occurred at 1330 h. The wound was immediately treated with Hydrogen peroxide, alcohol, and bandaged with Laevomecolum ointment. The jaws of the monitor lizard after seizing the soft tissues of the hand could only be released seven minutes later, while the monitor lizard "snorted" and made chewing movements. The first symptoms appeared after 20 minutes: gradually increasing pains of the muscles in the face, pharynx, neck and back, and pain when moving the eyes (at that time, 1 tablet each of Zodac [an antihistamine] and Nise [an anti-inflammatory drug] were taken). An hour later, all muscle tissues of the body ached, where trying to get up or just move caused severe pain (at that time, 10 tablets of activated charcoal were taken). Drinking and just swallowing was extremely painful. Touch to any part of the body also caused pain; breathing visibly worsened due to the difficulty of making respiratory movements, and mild tachycardia manifested. Two hours after the bite, nausea and diarrhea appeared (another 10 tablets of activated charcoal were taken). By 1800 h the symptoms did not subside and the need for medical assistance became apparent. By 2000 h vomiting began, after which the nausea subsided, and a little later the general pain slowly began to subside. It was possible to get to the hospital and receive an IV drip (saline 500ml + sodium thiosulfate 10 ml) and an injection against tetanus (Diphtheria and Tetanus Toxoid 0.5 intramuscularly) by 2240 h. After that, the pain began to subside more quickly and at midnight I managed to eat a little and go to sleep. At 1030 h the next morning (21 hours after being bitten), the pain remained only in the neck muscles.

Attention is drawn to the absence of an inflammatory process at the site of the bite (Fig. 3). The wound on the arm did not inflame either immediately or during the healing process; local pain was not felt and the tissue was not swollen.

By lunchtime the next day (the day after the bite), the symptoms of the venom were gone completely. A detailed blood test on the third day after the bite did not reveal any changes - all blood parameters were normal. Wounds completely healed rather quickly within 12 days. In the locations where the teeth had punctured the skin, some scarring formed which was palpable for the next month, and for another two months there was an itch. All symptoms at the site of the bite disappeared completely after three months.

In my opinion, the tactics of the monitor lizards' hunting play an important role in understanding the toxicity of *V. griseus*. Grabbing the prey, the desert monitor lizard holds it as tight as possible. Small prey are not chewed, but immediately swallowed, or, by squeezing it with the jaws, the monitor waits until the victim ceases to attempt escape, and consumes it after that. Instead, the monitor lizard tries to "chew" larger prey and, also without releasing it, swallows it. Sometimes this process can take a longer time. This tactic of hunting speaks in favor of the immobilizing action of toxins in the saliva.

Arbuckle (2009) believes that for monitor lizards that prey mainly on small animals, it is difficult to see the benefits of using venom to immobilize the victim. The powerful jaws of the monitor lizard allow for inflicting quite severe damage to medium-sized prey, which often leads to a quicker death and minimal risk of injury to itself. The benefits of using venom are evident in those species of monitor lizards that prey on potentially dangerous animals, such as large mammals or venomous reptiles. One of these species is *V. komodoensis*, the Komodo dragon, which regularly

Fig. 3. Wound six hours after the bite from a *V. griseus caspius*.

attacks large mammals that exceed its size. Such prey can pose a serious danger for the monitor lizard, so the venom of *V. komodoensis* plays an important role in its hunting. Research of Fry *et al*. (2008) focusing on the Komodo dragon, confirms the presence of venom glands and the central role of the venom in catching prey. Phospholipases found in its saliva act as a powerful neurotoxin and can also destroy the structure of molecules, thus helping to digest food items (Condrea & De Vries, 1965; Harris, 1997). However, according to Arbuckle (2009), the main function of venom in monitor lizards is not immobilization of the prey, but rather an increase in the speed and/or efficiency of digestion. To test this hypothesis, experimental studies are needed comparing the digestion of food objects in *Varanus* with and without the application of venom.

To consider the issue of toxicity of the saliva of monitor lizards, based only on an assessment of the size of their prey is not entirely correct, because the monitor lizards are carnivorous. The diet of the desert monitor lizard is varied and varies depending on individual conditions. Thus, despite the doubts of some researchers towards the venomousness of the desert monitor lizard, the toxicity of its bite is confirmed by the observations reported above. This toxicity is aimed at immobilizing the victim, and, apparently, at facilitating its digestion. There is a pronounced neurotoxic effect after the bite of the monitor lizard, *i.e*., paralysis of the skeletal and respiratory muscles, as a result of exposure to the nervous system and muscular tissues. The enzymes found in the saliva of the desert monitor are similar to snake venoms. According to Abubakirova (1997), the saliva collected at the base of the teeth of *V. griseus*, where the excretory ducts of the Gabe gland have an exit, contains hyaluronidase, a protease and nerve growth factor (NGF). Hyaluronidase enhances the permeability of capillaries at the site of the bite and increases the speed of production of phospholipase A2 (a digestive enzyme that destroys cell membranes). Proteases on the one hand contribute to the breakdown of proteins, thereby starting the digestion process, and at the same time cause blood clotting disorders. NGF can inhibit inflammation and increase the permeability of the vascular wall. The toxic effect of venom in combination with the force of the bite, the application of ragged wounds, and severe tissue damage makes the desert monitor lizard a universal predator capable of changing prey types and independent of third-party influences on the diet. Further experimental studies of the toxicity of the desert monitor lizard, which could shed light on the features of its biology and physiology, are desirable.

Acknowledgments - I thank André Koch for some helpful comments on an earlier version of this short note and help with translation.

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Received: 17 June 2019 Accepted: 9 December 2019

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