

# BLAWAK

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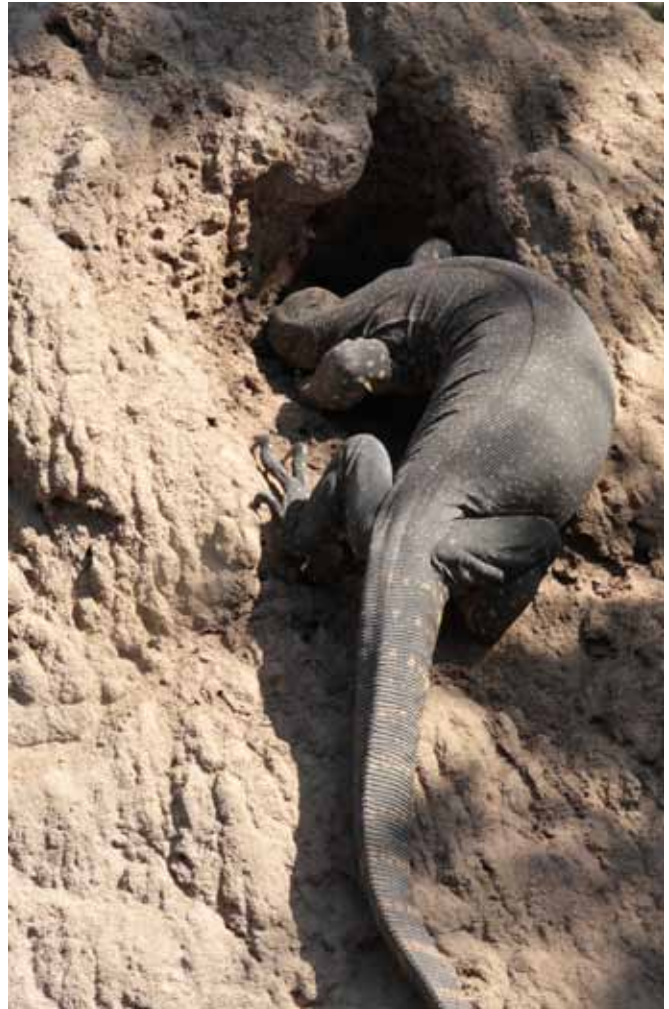
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# On the Cover:

## *Varanus rosenbergi*

The heath monitor, *Varanus rosenbergi* depicted on the cover and inset of this issue was photographed by **David Kirshner**. In March 2012, a female *V. rosenbergi* was observed digging potential nest holes into a termite mound (*Nasutitermes exitiosus*) in a park near Sydney, NSW, Australia. The female worked on two separate holes on either side of the same mound, pausing frequently to look around for predators or to bask. David returned to the mound on subsequent days and watched the female continue to work on the holes, although she was interrupted by a few days of rain. On one visit to the area the same female was observed basking on a nearby rock, where the lack of fat reserves in her tail was clearly visible, indicating that she was very close to laying. However, egg laying was not observed and it is believed she was probably disturbed by hikers on a sunny weekend when the park was particularly busy.







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# BIAWAK

*Journal of Varanid Biology and Husbandry*

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INTERNATIONAL VARANID INTEREST GROUP  
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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.



Organizational News.....	67
News Notes.....	68
First Record of <i>Varanus bitatawa</i> in the Philippine Pet Trade	
.....EMERSON Y. SY	73
Heds you Lose, Tails You Win: Notes on a Tail-assisted Foraging Behavior in <i>Varanus (Odatria) kingorum</i>	
.....KIDAN PATANANT	74
First Record of <i>Varanus rudicollis</i> from Penang, Malaysia	
.....RAY HAMILTON	78
Notes on the Husbandry and Breeding of the Black Tree Monitor <i>Varanus (Euprepiosaurus) beccarii</i> (Doria 1874)	
.....DENNIS FISCHER	79
Historical Facsimiles.....	88
Current Research.....	95
Recent Publications.....	96

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*Varanus niloticus*. Kruger NP, South Africa. Photographed by **Kim Paffen**.

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# ORGANIZATIONAL NEWS

## Call for Articles and Photographic Submissions

*Biawak* is seeking written and photographic contributions which detail various aspects of varanid biology including, but not limited to ecology, natural history, behavior, captive management and reproduction, and veterinary medicine. Written submissions may be full length research articles, review articles, husbandry and breeding reports, brief reports, veterinary case reports, geographical distribution notes, historical perspectives, biographies, and bibliographies. Additional topics will also be considered.

Language assistance and assistance with manuscript preparation are available to those who inquire. For additional information on article and photographic submissions, please contact [submissions@varanidae.org](mailto:submissions@varanidae.org).

## Translational Assistance Needed

In an effort to further increase the availability of information on varanid lizards to researchers and enthusiasts worldwide, *Biawak* is currently seeking capable bilingual individuals for assistance with translating previously published German, Dutch, Russian, and Indonesian language works into English. For additional information about becoming a translator for *Biawak*, please contact [submissions@varanidae.org](mailto:submissions@varanidae.org).

## *Varanus* Chat Radio Program

The International Varanid Interest Group has recently founded an online radio program as a supplement to the various informational resources it currently offers to varanid researchers and enthusiasts. The program will feature news briefs, digests of current research, and guest appearances from varanid researchers, zoo professionals, and private breeders. Although the program will be broadcast live, podcasts of each episode that can be listened to at any time will also be available for free download.

Although an official date for the inaugural episode has not yet been determined, additional details about the program and updates will be posted on the IVIG's website, <http://varanidae.org>.

## Bibliotheca Varanoidea

Since 2007, *Bibliotheca Varanoidea*, an online message board dedicated to the non-commercial peer to peer exchange of published varanid literature, has enabled many researchers and enthusiasts to locate and acquire obscure and difficult to obtain works on the genus *Varanus*. The success and utility of this resource depends largely upon the altruism of its participants as well as the number of active participants originating from different parts of the globe that may have access to different published works. Access is available through the IVIG website, <http://varanidae.org>.



*Varanus mitchelli* and Australian keel-back *Tropidonophis mairii*. Litchfield NP, Northern Territory. Photographed by **Peter Brady**.



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# NEWS NOTES

## Child's Remains Partially Consumed by Monitor Lizard

The remains of a two year old child were discovered after having been partially consumed by a monitor lizard, presumably an Asian water monitor (*Varanus salvator macromaculatus*). The boy disappeared near Segaliud Forest Reserve outside of Sandakan, Sabah, Malaysia. The cause of death has yet to be determined.

Source: *The Star/Asia News Network*, 17 November 2012

## Water Monitors Investigated by Secret Service as 'Potential Threat'

U.S. Secret Service agents preparing for the arrival of President Barack Obama at the Government House of Thailand initially identified the resident water monitors (*Varanus salvator macromaculatus*) as a potential threat to the President's visit. The investigation appears to

have been prompted by confusion between the large but typically harmless water monitors and the related Komodo dragon (*Varanus komodoensis*) which has seldom been known to injure humans. Thai officials later corrected the agency's confusion and informed them that the large animals pose no threat.

Source: *Mail Online*, 17 November 2012

## Komodo Dragon Bites Woman on Rinca

A Komodo dragon (*Varanus komodoensis*) bit an elderly woman on Rinca as she was tending to her livestock. The woman sustained lacerations to her leg and was taken to the Labuan Bajo community health clinic for treatment. Officials are currently monitoring her condition. No word was given on exactly what might have prompted the attack, though the close proximity of livestock is likely to have been a factor. (*Editor's note*: Sources had stated that Komodo dragon 'antivenom' was flown in from Bali for the victim's treatment. Despite recent revelations that the bite of *V. komodoensis* may have venomous properties, no antivenom currently exists



*Varanus albigularis*. Kruger NP, South Africa. Photographed by René Rossouw.



*Varanus rosenbergi* deceased on road with shingleback skink (*Tiliqua rugosa*). Near Waychinicup NP, Western Australia. Photographed by **Julia M. Ruckh**.

and the sources were most likely referring to antibiotic treatment.)

Source: *The Jakarta Post*, 13 October 2012

## Vietnamese Authorities Seize Monitor Lizards

Customs officers in central Ha Tinh Province, Vietnam have seized ten large live water monitors (*Varanus salvator*) that were in the process of being smuggled. The animals were being transported in individual sacks by an unknown individual on a motorbike. After a chase, the individual fled the scene leaving the animals by the roadside. Authorities are working to determine the animal's exact origin and have noted that the necessary steps have been taken to release them back into the wild.

Source: *Tuoi Tre News*, 7 September 2012

## Construction Work Partially Implicated in Komodo Dragons Living Outside Protected Areas on Flores

The East Nusa Tenggara (NTT) Natural Resource Conservation Center (BBKSDA) has estimated that at least 40 Komodo dragons (*Varanus komodoensis*) are living outside of protected areas in West Manggarai Regency. Reports include animals from as far as Nampar Sempang village in East Manggarai, including a young male that was captured by officials and relocated to a protected area. The animal had suffered injuries from an unknown source and was treated with antibiotics. Dragons living in the vicinity of Tompong Beach near Pota in the Sambi Rampas district of Flores have relocated due to road construction taking place. It is believed that the use of explosives has caused the animals to flee. Arsyad, a dragon caretaker, stated that



eight large animals and numerous smaller individuals were normally found on the beach but have since relocated. The BBKSDA is dispatching teams to locate stray dragons. In addition, the agency is conducting surveys in the areas of Wolo Tadho, Riung and Ontoloe Island with the goal of aiding dragon conservation outside of national parks.

Source: *The Jakarta Post*, 28 August 2012; 2 September 2012

## Sri Lanka Receives its First Komodo Dragons

The Dehiwala Zoo in Colombo, Sri Lanka has received a pair of Komodo dragons (*Varanus komodoensis*), the first of its species to be displayed in Sri Lanka, from Prague Zoo, Czech Republic. The dragons were part of a larger exchange program between the zoos, with the Dehiwala Zoo also receiving a pair of Przewalski horses and a pair of river hippopotamuses in exchange for a pair of Sri Lankan elephants.

Source: <http://www.sundaytimes.lk>, 28 October 2012

## New E-Books on Australian Monitor Lizards

Two self-published e-books on Australian monitor lizards have just been released by author Gunther Schmida. A third volume which will deal with Australia's larger monitor species is currently in preparation.

*The Australian Goanna Pictorial* features 100 pages of high quality photographs covering almost all species, including many color variants of the highly variable species. All images were taken in the wild or in appropriate captive surroundings. Text has been kept to a minimum. This pictorial guide can be used as a quick computer reference to the Australian species, and individual pages can be printed to A4 size with excellent results.

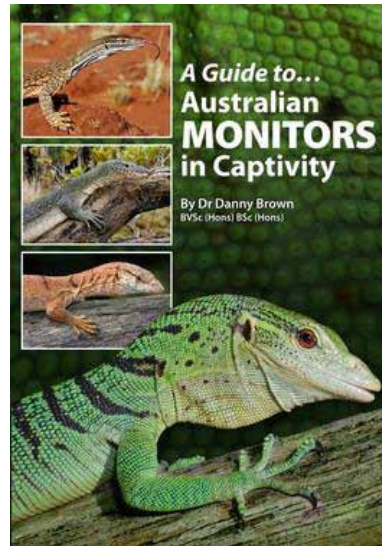
*The Goannas of Australia – 2* is a 106 page reference book which provides essential information and quality

photographs of Australia's smaller monitor species including their common and scientific names, author and year of their descriptions, type localities, and maximum sizes. An up-to-date distribution map with reference points, habitat photographs, and additional biological information are also provided for each species.

Both volumes are aimed at the general Australian public, especially 10 to 14 year olds, as well as monitor lizard enthusiasts worldwide, and are currently available for preview and purchase through the website [www.guntherschmida.com.au](http://www.guntherschmida.com.au)

## New Book on Monitor Lizard Husbandry

A new book authored by Danny Brown on the captive maintenance of monitor lizards entitled "A Guide to Australian Monitors in Captivity" has just been released by Reptile Publications. According to the publisher:



"This full colour, 264 page book provides detailed information on all aspects of captive husbandry relating to the most commonly kept species of Australian monitor species including large terrestrial and

arboreal monitors, rock monitors, small terrestrial monitors, small and medium arboreal monitors and water Monitors.

The book is littered with full colour images showing all aspects of sexing, housing, breeding and general appearance of the species within each chapter using over 400 images from some of Australia's finest reptile photographers, most unique to this book series..."

Source: <http://reptilepublications.com>, 20 December 2012



*Varanus bengalensis*. Yala NP, Sri Lanka. Photographed by **Pedro Ferreira do Amaral**.

## New Monitor Lizard Magazine

A new German language magazine entitled *Monitor Lizards* (ISSN: 2195-4380) has just been released in November 2012 by the group Waranwelt. The magazine is a non-profit venture which aims to spread information



about the keeping and breeding of varanid lizards in captivity, and each issue will focus on a different subject.

The premier issue has been dedicated to *Varanus macraei*, and features articles discussing its climate and ecology, and feeding, and breeding in captivity. Although

there are no specific release dates for the magazine, two or three issues are planned annually. Issue number two will be released in February 2013 and will focus on *V. acanthurus*.

Additional information and ordering details can be found at <http://waranwelt.de>

## Komodo Dragons Hatch at Barcelona Zoo

On 20 November 2012, Barcelona Zoo became the second facility in Spain to have successfully reproduced Komodo dragons (*Varanus komodoensis*). A total of 16 eggs were produced by a female that is on loan from the Prague Zoo, Czech Republic and a male originating from Reptilandia, Gran Canaria, Spain. As of 5 December 2012, all but two eggs have hatched.

Source: <http://www.larazon.es>, 21 November 2012; <http://zoobarcelona.cat/en/news-and-press>, 5 December 2012

## Surveillance Cameras Discover Komodo Dragons on Ontoloe Island

In collaboration with the Komodo Survival Program (KSP), surveys recently conducted by the Center for Natural Resources and Conservation of East Nusa Tenggara (NTTBBKSDA) have identified at least six



to eight Komodo dragons (*Varanus komodoensis*) on Ontoloe Island, located off the northern coast of Flores, Indonesia.

In this study, nine camera traps were set up on Ontoloe and monitored between 28 September - 2 October 2012. Seven cameras captured dragons. According to the photographs, the dragons appeared in good physical condition, with thick and robust tail bases.

With these results, the NTTBBKSDA will look to the possibility of promoting Ontoloe as a site for ecotourism, and security patrols in the region have been tightened to monitor activity that could affect the habitat of these animals. Annual surveys of the dragons on Ontoloe are planned.

Source: <http://www.mongabay.co.id>, 22 November 2012

## Brutal Attacks on Wildlife in Kimberly Region

The Freshwater Fish Group and Indigenous rangers operating in the Fitzroy River area of the Kimberly Region, Northern Territory, Australia, have recently noted an increase in illegal attacks on local wildlife including crocodiles, sawfish, and monitor lizards. In one case, an arrow was shot through the neck of a large yellow spotted monitor lizard *Varanus panoptes panoptes*. The group says it will report these recent incidents to the relevant authorities.

Source: <http://www.abc.net.au>, 30 October 2012



*Varanus rudicollis*. Gunung Leuser NP, Sumatra. Photographed by **Arthur Anker**.

## First Record of *Varanus bitatawa* in the Philippine Pet Trade

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**Abstract** - Described in 2010, *Varanus bitatawa* is recorded for the first time in the Philippine pet trade. An asking price of ₱ 100,000 PHP (\$2,380 USD) suggests that the seller was aware of its highly-coveted status in the pet trade.

Closely grouped together with *Varanus olivaceus* and *V. mabitang*, *V. bitatawa* is the most recently described frugivorous monitor lizard from the Philippines (Welton *et al.*, 2010). In northeastern Luzon, *V. bitatawa* is an important source of protein and traded bush meat for the indigenous Agta and Ilongot tribes (Welton *et al.*, 2010, 2012). While the IUCN lists *V. olivaceus* as vulnerable and *V. mabitang* as endangered, *V. bitatawa* has yet to be assessed (IUCN, 2012). All Philippine monitor lizards are accorded legal protection under the Wildlife Act of the Philippines.

Dealers formerly displayed illicit wildlife openly in major pet centers of Metro Manila and in some major cities. Over the last five years, many wildlife dealers and hobbyists have increasingly utilized local trading and social networking websites to trade in exotic and indigenous wildlife. On 5 May 2012, a wildlife dealer located in the Philippines posted a photograph of a *V. bitatawa* being offered for sale on a popular social networking website (Fig. 1). The adult specimen was reported to weigh 15 kg and measure 1.7 m in total length, and was priced at ₱ 100,000 PHP (\$2,380 USD).

Of the three known frugivorous monitor lizards, only *V. olivaceus* is regularly observed in the Philippine pet trade, where the asking price for hatchling-sized to juvenile animals (< 3 kg) ranges from ₱ 1,500 to 3,500 PHP (\$36 - \$83 USD) (pers. obs.). The relatively high asking price for *V. bitatawa* described here suggests that the seller was well aware of wildlife collectors' willingness to pay a high price for a newly-described species.

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Fig. 1. Screen capture of the *Varanus bitatawa* being offered for sale.



## Heads You Lose, Tails You Win: Notes on a Tail-assisted Foraging Behavior in *Varanus (Odatria) kingorum*

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**Abstract** - This article describes a tail-assisted foraging behavior in *Varanus kingorum*, a small rock-dwelling varanid from Australia. Numerous captive specimens were observed skillfully using their tails to extract prey from tight crevices which were otherwise unreachable by the lizards. This behavior was displayed by individuals of both sexes and all age groups, and it is therefore hypothesized that it is, at least to some extent, genetically fixed.

### Introduction

Varanid lizards are a diverse group of reptiles not only in regards to variation in size within the family, but also in their use of different structural habitats within their natural range. Four main structural habitat types have been identified that are “characterized by the physical environment” (Bedford & Christian, 1996): arboreal, arboreal/semi-aquatic, terrestrial, and rock-dwelling (Greer, 1989; Collar *et al.*, 2010; Collar *et al.*, 2011). While varanids may not appear to differ widely in their overall appearance to the herpetological layperson at first glance, each species has evolved specialized morphological and behavioral adaptations for survival in its preferred habitats.

Tail morphology in particular can give hints as to which structural habitats are used by a species, and studies have shown that certain tail characteristics correspond to specific habitats and lifestyles in varanids (Bedford & Christian, 1996). While arboreal species such as members of the *Varanus prasinus* complex feature prehensile tails which aid in climbing (Greene, 1986; 2004), highly aquatic species such as *V. mertensi*, *V. niloticus* and *V. salvator* have developed laterally compressed tails which make swimming more efficient (Bedford & Christian, 1996). *Varanus acanthurus*, a primarily terrestrial species, uses its spiny tail to block the entrances to burrows, presumably for protection from predators (Wilson & Knowles, 1988; Auffenberg, 1994). Lastly, rock-dwelling species of the subgenus *Odatria* including *V. glebopalma*, *V. glauerti*, *V. pilbarensis* and

*V. kingorum* have developed very long tails in relation to their snout to vent lengths (SVL), which act as counterbalances when moving around rocky habitats (Bedford & Christian, 1996).

Tail usage for purposes other than aiding in locomotion, security, or fat storage have been described for several varanid species (Hermes, 1981; Gaulke, 1989; Eidenmüller, 1993; Horn, 1999; Keith & Ginsburg, 2010; Wickramasinghe *et al.*, 2010). Three of these reports describe the usage of the tail to extract prey items from burrows and crevices which were otherwise unreachable (Gaulke, 1989; Eidenmüller, 1993; Horn, 1999). Eidenmüller (1993) reported this behavior in captive *V. acanthurus*, with lizards using their tails to extract crickets from under cork slabs. Here, a similar tail-assisted foraging behavior is described in captive specimens of *V. kingorum*, the smallest (to 35-40 cm in total length [TL]) of the four aforementioned rock dwelling species within the subgenus *Odatria*, with a tail that can reach 2.3 times its SVL (Storr, 1980; King, 2004).

### Captive Husbandry

*Varanus kingorum* (Fig. 1) was first acquired by the author in 2009 and has since been bred consistently through multiple generations. Incubation period has ranged from 89 to 126 days at a temperature of 29 +/- 2 °C. Snout to vent lengths and tail lengths of hatchlings



Fig. 1. *Varanus kingorum* have extraordinarily long tails which they can use to extract prey from otherwise unreachable crevices.

have averaged around 5.0 cm and 9.5 cm respectively, and therefore fall within the ranges reported by others (Eidenmüller, 1999; Retes & Bennett, 2001; Eidenmüller, 2003).

Adult pairs are kept in adequately sized enclosures with a thick layer (ca. 15-25 cm) of mostly inorganic substrate such as sand of varying grain sizes with a smaller share of organic matter. Heat-tolerant plants such as *Callistemon sp.*, cork tubes, rocks, and stacks of flat wood arranged to imitate rock crevices that would be used in the wild, are also provided. The wood and rock stacks increase usable surface area, create artificial crevices, and depending on their construction and arrangement, offer tight-fitting refuge sites with different humidity levels and temperature gradients. The heights of these artificial crevices range from 1.5 cm on one side, narrowing down to 0 cm on the other.

Their diet consists of cockroaches (*Blaptica dubia*), house and field crickets (*Acheta domesticus*, *Gryllus assimilis*) and the occasional baby mouse, which have not been accepted with gusto by most individuals of *V. kingorum* in the author's collection. Cockroaches are offered from forceps or placed in a food bowl, but crickets are released into the enclosure for the lizards to hunt freely. *Varanus kingorum* is a fast and agile hunter that preferably grabs its prey by the head and consumes it in typical varanid fashion.

### Behavioral Observations

Not all crickets introduced to the enclosures are consumed immediately and some take refuge in narrow, dark, and humid locations. Crickets are relatively easily captured by the lizards from within cork tubes and are

sometimes dug out from under rocks and wood slabs resting atop the sand substrate. However, the lizards face a problem when prey items seek refuge inside crevices too narrow for them to enter with their heads (Fig. 2a). This sometimes occurs when crickets hide in the narrow ends of the crevices created by the wood or rock stacks.

A clever solution to this problem has been observed in multiple *V. kingorum* of both sexes and all age classes. If a lizard realizes it cannot reach the cricket with its jaws, it switches to a different tactic. First, the lizard backs off, forming a semicircle with its body, with the tail tip facing the crevice where the cricket is located. It then begins to rapidly undulate the tip of its tail to force the cricket out of its safe hiding spot in the narrow part of the crevice (Fig. 2b). This works very efficiently, and in most cases the crickets are distracted by the fast moving tail and flee the crevice. The escape route for the cricket is defined by the body positioning of the lizard, which forces it to run directly towards the lizard's head, where it is then quickly grabbed and consumed (Fig. 2c). This all occurs inside the crevice provided it is large enough to accommodate the lizard. If the prey hides under smaller objects, the lizards perform the same behavior, sometimes reaching under the object with their tails from one side with the head on the other side waiting for the prey to emerge. The entire process can occur very quickly and be over in a matter of seconds.

### Discussion

As a species, *V. kingorum* appears to display this behavior instinctively, as individuals of all age classes, from hatchlings to adults have been observed hunting crickets in this manner. The frequency of its usage was



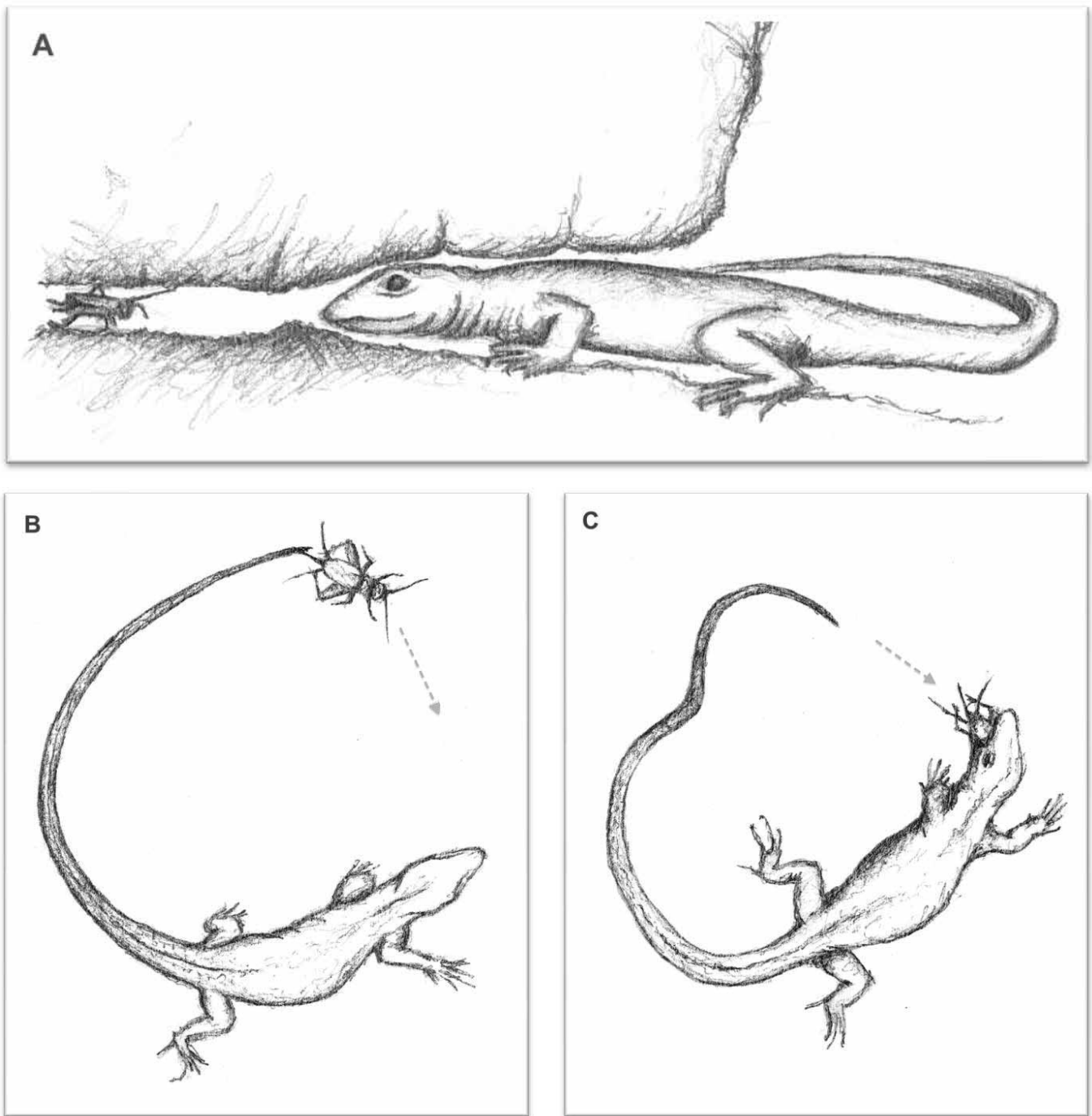


Fig. 2. Sketch of the tail-assisted foraging behavior. A) The prey item is visually and, or olfactorily located; however, the crevice is too narrow for the lizard to enter with its head. B) The lizard forms a semicircle with its body and rapidly undulates its tail tip to force the prey item out of its hiding spot. C) When fleeing the hiding spot, the prey is quickly grabbed and consumed by the lizard.

lower in hatchling individuals, most likely because they can easily access most crevices on account of their small size. The behavior is not randomly performed, and lizards do not check every available crevice in this manner just

to see whether there is prey inside. Instead, this tail-assisted foraging behavior is utilized purposefully when prey has been visually and, or olfactorily located by the lizard.

As this brief report and other publications (Eidenmüller, 1993; Horn, 1999) have shown, this behavior, or similar types of tail-assisted foraging are displayed by several varanid species belonging to different subgenera. The facts that juvenile and adult *V. kingorum* readily performed this behavior and it has been observed in multiple individuals suggests that it is at least to some extent genetically fixed and not something which is individually learned over time (e.g., Mendyk & Horn, 2011). Whether this type of tail-assisted foraging behavior evolved early on in the history of varanid lizards or independently in several species, remains speculative for now.

**Acknowledgments** - I want to thank Andrea Käsbohrer, Faris Bidier, Michael Evers, Andreas Franzke, Robert Mendyk, Marie Aschenbrenner, Jennifer Thomas, and two anonymous reviewers.

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## First Record of the Rough-necked Monitor *Varanus rudicollis* from Penang, Malaysia

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**Abstract - *Varanus rudicollis* is recorded from the island of Penang, Malaysia for the first time.**

In Malaysia, the known distribution of the rough-necked monitor *Varanus rudicollis* is poorly documented, with relatively few reliable localities scattered throughout Borneo and Peninsular Malaysia (Bennett & Liat, 1995). As far as it can be determined, there are no records of its occurrence on the island of Penang, Malaysia.

On 29 April 2008, a single specimen of *V. rudicollis* was observed and photographed on the island of Penang, Malaysia (Figs. 1 & 2). The sub-adult lizard was seen during mid-afternoon at rest in a tree, approximately 10 m off the ground. The lizard remained at rest in the same position during the ten minutes under observation. Apart

from a slight adjustment of its upper body position, the lizard was apparently unconcerned by our presence nearby. The canopy walkway from which the observation was made is located at the edge of a developed area bordered by dense forest, with mature trees and thick vegetation. The Penang Hill Canopy Walkway is located 1.7 km from the upper Penang Hill Railway Station, at an approximate elevation of 710 m above sea level at the summit of Penang Hill (Bukit Bendera), Malaysia (5° 25' 46.38"N; 100° 16' 3.68"E).

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Figs. 1 & 2. *Varanus rudicollis* observed from the Penang Hill Canopy Walkway, Penang, Malaysia.

## Notes on the Husbandry and Breeding of the Black Tree Monitor *Varanus (Euprepiosaurus) beccarii* (Doria, 1874)

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**Abstract - Problems experienced with the incubation and hatching of a clutch of *Varanus beccarii* eggs are described. One egg ruptured during incubation, and two eggs contained fully-developed, dead embryos. One surviving offspring was artificially hatched. Potential causes for these results are discussed.**

### Introduction

The black tree monitor, *Varanus beccarii* was first described by the Italian naturalist Giacomo Doria in 1874 as *Monitor beccarii*; named after his friend and colleague Odoardo Beccari. Mertens (1942) classified it as a subspecies of its close relative *V. prasinus*, which inhabits New Guinea and some smaller islands located within the Torres Strait. Sprackland (1991) elevated it to species status based on its homogeneous black coloration and distinctively keeled neck scales. As several additional species belonging to the tree monitor, or *V. prasinus* species complex have been discovered (e.g. *V. macraei* [Böhme & Jacobs, 2001], *V. boehmei* [Jacobs, 2003] and *V. reisingeri* [Eidenmüller & Wicker, 2005]) and others whose taxonomy has been revised or discussed (e.g., *V. bogerti*, *V. keithhornei*, *V. telenesetes* [Sprackland, 1991], *V. kordensis* [Jacobs, 2002]), a complete taxonomic revision is needed to better understand the taxonomic relationships of this group.

Despite its presence and relevance within the international pet trade for several decades, very little is known about the ecology of *V. beccarii*. Like other representatives of the *V. prasinus* complex, *V. beccarii* is suspected of inhabiting forest canopies, but may also descend to the ground to search for prey. Irwin's (2004) report on the closely related *V. keithhornei* from north Queensland, Australia may offer some insight on the behaviour and ecology of *V. beccarii* and other members of the complex.

The distribution of *V. beccarii* is restricted to Aru, a group of 95 islands located 150 km southwest of West Papua, covering a total land area of about 8,500

km<sup>2</sup>. Most of the archipelago is covered with tropical rainforest, while the coastline is distinguished by mangrove forests. Southern regions of the archipelago also support savannah habitats (Wallace, 1869). Precise climatic data from habitats inhabited by *V. beccarii* are lacking, but temperatures recorded in the archipelago's capital city of Dobo range from 25 °C at night (minimum of 22 °C) to 31 °C during the day (maximum of 34 °C). Total annual precipitation averages around 2000 mm (climate data acquired from <http://www.meteoblue.com>).

Indonesian traders export several hundred tree monitors each year to the European Union alone. Considering the limited distribution of most of these species and advancing habitat loss, these trade practices cannot be considered sustainable (Valoras, 1998; Nijman & Shepherd, 2009). For this reason, captive breeding is critical for reducing the demand and continued depletion of wild populations. However, despite the large numbers of specimens maintained in captivity, long-term success with keeping and breeding tree monitors is still rare. There have been relatively few published breeding reports for members of the *V. prasinus* complex which also highlight potential problems associated with their care and reproduction in captivity (e.g., Dedlmar, 1994; Bosch, 1999; Ziegler *et al.*, 2009). This article describes a successful breeding of *V. beccarii* and offers suggestions for improving husbandry in terms of enriching the captive environment and feeding methods, and discusses potential causes for failures experienced with egg incubation.



## Husbandry of Adults

An adult male *V. beccarii* was acquired in early 2011 to compensate the loss of an eight year old captive-bred male that had been housed together with a female and died four months earlier from an atypical mycobacterial infection. The female was acquired as a “farm-bred” subadult in 2010. After four weeks of quarantine, the male was introduced to the female. At this time, the male measured 26 cm in snout to vent length (SVL) and 74 cm in total length (TL) with a mass of 210 g; the female had a SVL of 29 cm, a TL of 80 cm, and a mass of 214 g.

The pair is housed together in a 160 x 120 x 185 cm (L x W x H) enclosure constructed from phenolic resin-coated plywood. The side and back walls are covered with baked cork plates, and the enclosure is further furnished with oak bark, branches, and vines. Some of the branches are freely suspended to encourage the animals’ coordination while moving amongst the artificial canopy. Other branches contain multiple drilled holes of varying diameters, some of which pass through the branch completely. These serve as enrichment (e.g., see Mendyk, 2012) when they are filled with very small pieces of cooked egg, fish, chicken bits or live

cockroaches from time to time. A heated (27 °C) 110 L water basin (157 x 50 x 15 cm) helps maintain a relative humidity of 70-95%. The enclosure is automatically misted six times a day at one minute intervals. Ambient temperatures range from 22-25 °C at night to 24-34 °C during the day. Illumination and basking sites are provided by two 75 Watt HQI spots (5600 K), one 150 Watt HQI spot (6500 K) and two 75 Watt halogen PAR spots (2900 K) (*Osram GmbH, München, Germany*). Surface temperatures beneath basking spots exceed 45 °C. Three leaf litter-filled nesting boxes constructed from phenolic resin-coated plywood (two of which measure 25 x 15 x 15 cm; the other 20 x 20 x 35 cm) provide opportunities for sleeping and egg deposition. A sliding door down the middle of the enclosure allows for separation of the pair. The enclosure is further furnished with several live plants (*Monstera*, *Ficus*, *Billbergia*, *Platynerium*, *Phalaenopsis*, *Zamia*, *Dracaena*, *Asplenium*, *Rhoeo* and *Epipremnum*) and a 5-15 cm thick layer of forest soil and withered oak leaf litter serves as substrate (Fig. 1). Ventilation is provided by two barred cuttings (ca. 8 x 40 cm) diagonally placed in the lower front and upper back of the enclosure.

More than 90% of the diet, by mass is comprised of insects (*Blaptica dubia*, *Pachnoda marginata*, *Zophobas morio* and others). Occasionally the animals are fed fish (*Osmerus sp.*), egg (chicken and snake; including shells), and day old chicks or beef (including bones and marrow). All live prey items are bred on site and gut loaded. Food is frequently supplemented with Herpetal Complete T (*Keweloh Tierernährung GmbH & Co., Osnabrück Germany*) and calcium citrate. Usual provisions are 10 to 20 g of food per animal per week. Animals are fed once or twice a week. Whenever possible, food is not offered from tongs but is instead either set free into the enclosure or placed into the prepared branches to encourage hunting and other foraging behaviors. A lively population of cockroaches, woodlouses and other arthropods populating rotten wood and leaf litter inside the enclosure offers additional opportunities to forage for small prey items.

## Courtship, Copulation and Nesting

Shortly after their introduction, the male began to pursue the female, usually approaching her with an increased frequency of tongue-flicking. In most cases the female retreated from the male, which often escalated into a fast chase through the enclosure that ended only when the female was able to distance herself from the male via a visual barrier. This enabled the female to



Fig. 1. Adult *Varanus beccarii* enclosure with live plants, natural substrate and dividing wall. Photographed by Claudia Ewerhardy.

reach a hideout before the male could spot her again.

Copulation was first observed on 25 December 2011, lasting for approximately two hours. Copulation occurred while the pair clung to the back wall of the enclosure; little movement was observed. Two additional instances of copulation were observed up until 1 January 2012. From this point onward, food was offered to the female every other day (ca. 7.5 to 9 g per feeding).

On 7 January, the pair was separated due to the male's continued attempts to initiate copulation. The female showed increased activity, but no digging was observed, and her abdominal girth and tail base area did not show any indications of gravidity. The female briefly refused insects and other food items for three days, but then reluctantly accepted two small cockroaches on 11 January and gorged on four cockroaches on 13 January. Since searching for eggs within the enclosure was unsuccessful, and the female showed normalized behavior, it was assumed that she was not gravid. The male was reintroduced later that day and immediately began to chase the female. Despite this aggressive courtship behavior, the pair was not separated.

Rather unusual, the female was the first to awake the following morning, appearing fairly exhausted but lacking any physical signs of oviposition. Nevertheless, the nesting boxes were searched for eggs. A clutch of three eggs was found buried in the moist substrate beside the water basin. While excavating the area, the ground was dug up carelessly and two of the eggs were scattered about the enclosure before they were found. All three eggs were white in coloration, but showed large indentations. Each egg was marked with a pencil, measured, weighed, and then placed inside a digitally controlled incubator (*Jäger & Pfrommer. Wächtersbach, Germany*).

### Incubation and Egg Development

All three eggs were stored separately in transparent plastic boxes with small ventilation holes. Vermiculite, initially moistened with distilled water at a 1:2 ratio by weight, served as an incubation substrate. The incubator's temperature was set to 30.5 °C, and the humidity level inside the incubator was 85%. Inside the egg boxes, the temperature recorded on top of the substrate was 30 °C and relative humidity was approximately 95%.

Weights and morphometrics of the eggs were recorded (Table 1). Candling the eggs with a common LED flashlight did not reveal blastodiscs or any other indication of fertility. By 16 January, all indentations in the eggs' shells had filled out, and each egg's weight had

Table 1. Egg measurements.

Egg No.	Weight (g)	Length (mm)	Width (mm)
1	11.7	46	21
2	11.3	45	20
3	11.3	46	23

increased by an average of 0.8 g. Further developments in egg weights are documented in Fig. 2.

One month after deposition, the eggs still lacked any visible signs of fertility when candled with a 40 watt bulb, but continued to grow steadily. After three months, candling showed diffuse shadows, which, in one case exhibited movement. On 23 April 2012, the candling method was improved by switching to a cardboard tube and a 15 Watt energy saver bulb, which resulted in an impressive view of the embryo (Fig. 3). Remarkably, all three embryos were positioned towards the bottom of the egg, beneath the yolk. Further candling showed that the embryos maintained this position throughout incubation, which is quite different from the usual position described in the literature (Köhler, 2004).

On day 136, egg #3 was removed from its box for measurement; its mass had increased to 265% of its original weight (see Fig. 2). Inspection of the egg revealed a rupture on its underside created by a 10 mm long fissure in the shell. A large gelatinous clot of what appeared to be allantois and vermiculite clung to the egg. As there was no visual indication of infection or smell of decay, the egg was turned over and immediately repaired. Because the egg continued to spill out more allantois as the fissure was cleaned, it was necessary to stop the leak with cellulose pulp before the fissure was sealed with hot wax (Fig. 4). Three days later, the egg still smelled fine and candling revealed movement.

Since egg #2's weight had decreased for one week and did not show any signs of movement during daily candling, it was manually opened on day 159, revealing a fully developed, dead embryo (Fig. 5). The reason for its death remains uncertain, as no signs of infection were visible. The embryo weighed 9.64 g and had an attached yolk sac that weighed 1.1 g. Based on the egg's weight development over the last several days (see Fig. 2), the pale coloration of the yolk sac, missing blood vessels, and the cloudiness of the allantois, it was estimated to have died around one week earlier.

Around 1630 h on 22 June 2012, after 161 days of incubation, egg #3 began to sweat heavily. Unlike the day before, candling showed no blood vessels on the



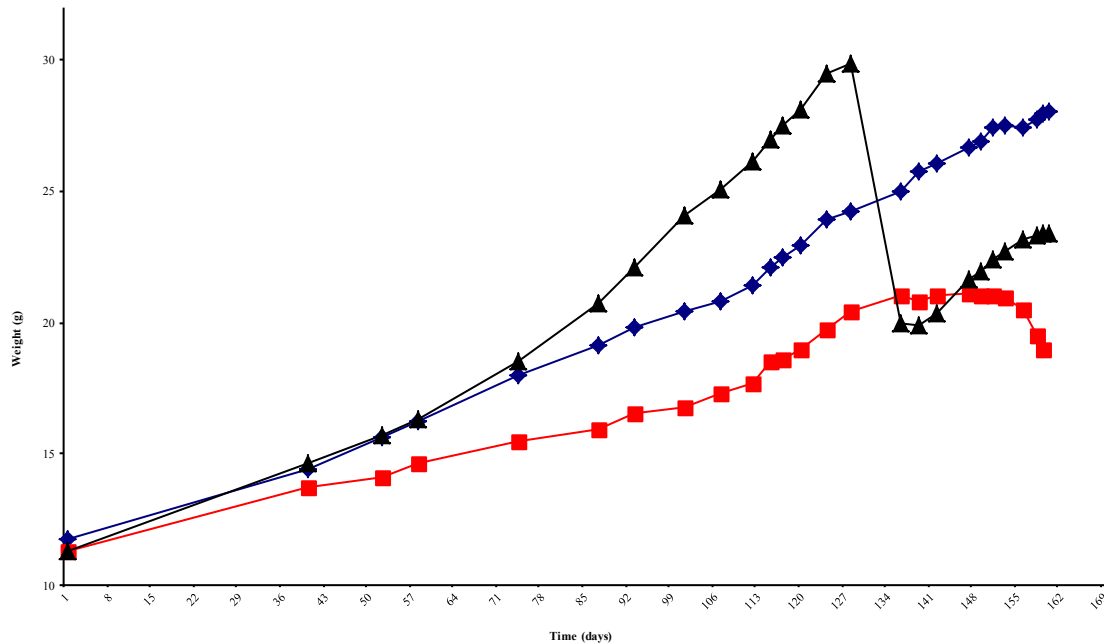


Fig. 2. Clutch development during incubation. Blue diamonds = egg #1; Red squares = egg #2; Black triangles = egg #3

upper inside of the egg. Although the box was opened for better ventilation, the egg continued to visibly sweat until at least 0530 h the following morning. By 1030 h on 23 June, there was no sign of hatching. The egg was then manually opened, also revealing a fully developed, dead embryo. Based on the egg's continued sweating until the early morning, the vivid coloration of the yolk sac and its blood vessels, and the clear opacity of the allantois, the time of death was estimated to have been just a few hours earlier. Further investigation of the repaired fissure and the wax seal did not reveal any cause for the embryo's death. In fact, the wax and cellulose pulp were still in perfect condition and did not

show any signs of infection or decomposition (Figs. 6 & 7).

Due to the loss of both well-developed eggs, it was decided to open the remaining egg right away. The usual procedure would be to cut a window in the egg's shell and manipulate the embryo's head out, in order to encourage it to breathe and complete the hatching process on its own (Köhler, 1989, 2004). Since the head's location could not be determined with candling or by opening the egg with a small incision, the shell was opened along its length to expose the embryo. The live offspring was immediately transferred to a box with moist paper towel and stored in the incubator (Figs. 8 & 9). Shortly after



Fig. 3. Candling revealed the position and body features of the embryo in egg #1 on day 100 of incubation. Photographed by **Claudia Ewerhardy**.



Fig. 4. Wax seal on egg #3, one month after repair. Photographed by **Claudia Ewerhardy**.



Fig. 5. Dead, fully-developed embryo from egg #2, showing no signs of decomposition besides the faint color of the yolk sac. Photographed by **Claudia Ewerhardy**.

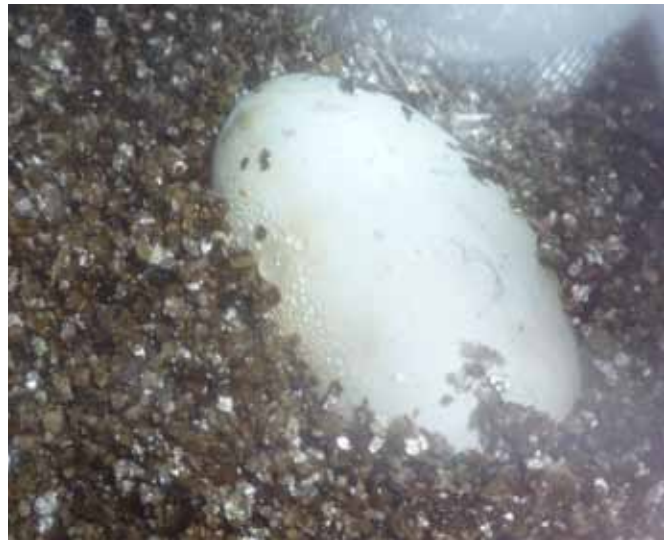


Fig. 6. Egg #3, sweating. Photographed by **Claudia Ewerhardy**.



Fig. 7. Dead, fully developed embryo from egg #3. Note the difference in yolk sac color compared to embryo #2 (Fig. 5). Photographed by **Claudia Ewerhardy**.



Fig. 8. Exposing the live embryo from egg #1. Photographed by **Claudia Ewerhardy**.



Fig. 9. Surviving neonate *V. beccarii* inside incubator after its forced hatching. Photographed by **Claudia Ewerhardy**.



its emergence, it showed signs of heavy breathing in the throat and thorax. Very little movement was observed and its eyes remained closed for the remainder of the day. By the following day, the hatchling had begun to perk up, supporting itself with the forelimbs. At this time it was decided that the remaining yolk sac no longer had a functional connection to the hatchling and was removed with heated scissors by cutting the umbilical cord. Nourishment with water and raw egg was attempted, but failed. Later that day the hatchling began to move around slowly. Its behavior appeared calm, but vigilant.

### Husbandry of Offspring

On 25 June, the hatchling was transferred to a quarantine enclosure measuring 40 x 30 x 25 cm and furnished with moist paper towel, thin oak branches, and a small *Ficus benjamina* for coverage. Several food items of suitable size were offered daily (insects, beef, egg, fish), but refused. Direct misting of the juvenile encouraged it to drink. Hatchling members of the *V. prasinus* complex often refuse to take any food for up to two weeks (Pelgen, 2011), and sometimes even longer (F. Mohr, pers. comm.). Nevertheless, force-feeding was initiated after a week due to a planned absence for 12 days and the suspected compromised physical condition of the offspring given its inability to absorb its yolk sac. Supplemented pieces of beef and day-old chicks were used for daily force-feeding. After one week, force-feeding was stopped, and the temporary caretaker offered food items daily. During the second week of absence, the temporary caretaker initiated force-feeding again on a two day cycle because weight measurements showed a decrease in body mass; food items were still offered daily. This cycle was maintained until the offspring began accepting food on its own on 25 July, one month after hatching.

No other live food items besides flies (*Musca sp.*, *Sacrophaga sp.* and *Lucilia sp.*) were accepted. To ensure a more controllable, supplemented diet, an omelett was developed. The recipe contained one part (by weight) egg, 1.5 to two parts mixed insects (ca. 70% *Blaptica dubia*, 20% *Pachnoda* larvae and beetles, 10% *Zophobas* larvae), 0.5 to one part banana or spinach, one teaspoon of calcium citrate and one scoop (0.9 g) of *Herpetal Complete T*. Banana and spinach were added to supplement the mixture with carbohydrates and fibers which are naturally low in a carnivorous diet. While Greene (1986) did not list any plant matter in his study of stomach contents of several tree monitor species, some authors suggest the occasional feeding of fruits (Rogner,

1994; Sprackland, 1999). This is backed by several observations of tree monitors occasionally feeding on live plants in captivity (e.g., *V. prasinus* [Simon, 2011], *V. beccarii* and *V. macraei* [Mohr, 2011]). The insects were mixed with the egg, vegetables and supplements, pureed, and then baked in a microwave oven. This offered the juvenile a well-apportioned fiber-rich diet based on its natural, primarily insectivorous diet (Greene, 1986).

Due to its high activity levels, the offspring was moved to an 80 x 60 x 110 cm enclosure on 24 July 2012. The terrarium is fully furnished with baked cork plates lining the walls, oak branches, live plants, and a 40 L water basin that is heated to 30 °C to help maintain a minimum temperature of 24 °C at night and a high relative humidity. Illumination and heat is provided by two 23 Watt Dulux Superstar energy saver bulbs and a 75 Watt halogen PAR spot (*Osram GmbH, München, Germany*).

Despite daily offerings of this diet, the juvenile did not significantly increase in weight or begin to grow for several weeks. Measurements taken on 9 September 2012 eventually showed a vital growth in length and weight that continues to this day (Table 2). Five months after its forced hatching, the juvenile accepted live *B. dubia* for the first time, and only a few days later accepted *Pachnoda* larvae. The young monitor shows an astonishing activity level and becomes less nervous and timid each day.

### Discussion

Tree monitors, or members of the *V. prasinus* complex, have frequently been imported to Europe and North America for several decades. While the average physical condition of imported specimens has greatly improved over the last several years, consistent, repeatable breedings are still scarce. A problem experienced by many keepers is the death of fully developed embryos shortly before or during the hatching process. Some suspected causes include an excessively high level of substrate moisture during the last third of incubation resulting in extensive pressure build-up inside the egg, excessively thick egg shells caused by a prolonged gestation period, and insufficient maternal nutrition where females lack an appropriate supply of essential vitamins and minerals needed for egg production (Köhler, 2004).

While published breeding records for tree monitors do not mention offering an extra supply of vitamins and minerals to gravid females in addition to the usual supplementation recommended (Dedlmar,

Table 2. Hatchling measurements. DIE= dead in the egg .

Hatchling No.	Date of Measurement	SVL (cm)	TL (cm)	Hatchling Mass (g)	Mass of Yolk Sac (g)
1	hatching	8.5	18.5	7.9	0.7
	6 weeks	10	22.5	10.2	-
	15 weeks	10.5	24.5	11.9	-
	21 weeks	11.5	27	13.8	-
2	DIE	8	18.8	9.6	1.1
3	DIE	7.5	17.5	10.4*	n/a

\* hatchling and yolk sack weights combined

1994; Eidenmüller, 2003), deficiencies can result in a poor physical condition of the female. Köhler (2004) and many private breeders in Europe have identified nutritional deficiencies as the most important underlying cause for incubation failures resulting in dead, fully developed embryos. However, signs of vitamin and mineral deficiency could not be confirmed for the dead embryos in this report. Kiehlmann (2012) recommended pressing the heads of the embryos as an indicator of insufficient skeletal mineralization. This was performed on both dead embryos, but their heads and skeletons seemed as stable as one would expect for a lizard of that size.

It remains uncertain if a prolonged gestation period due to the absence of suitable egg deposition sites resulted in excessive calcium accumulations within the egg shells (Köhler, 2004). Comparative vernier calliper measurements (to the nearest 1/20 mm) off egg shells from the failed *V. beccarii* eggs and from successfully hatched *V. macraei* eggs showed no significant differences in thickness.

Lizard embryos are known to use both an egg tooth and their claws to shear apart their egg shells (Köhler, 2004). However, the embryos in this study did not appear to have reached the point of the hatching process where they would attempt to slit their egg shells. While egg teeth were present and well developed in all three embryos (Fig. 10), an inspection of the shells showed no signs of perforation on the inner side of the shell or membrane. Moreover, the embryos' claws were still covered by the neonychium, a temporary tissue which covers the claw tips during their development and is then shed around hatching (Alibardi, 2009). This tissue may prevent the embryo from lacerating vital structures inside the egg during development.

While eggs of some varanid species successfully hatch when incubated under different substrate moisture levels, from “dry” to “wet” (Phillips & Packard, 1994; Walsh *et al.*, 2002), others, such as tree monitors, may not be as tolerant. Many breeders successfully use vermiculite as an incubation medium, but a moist substrate may be a suboptimal choice for incubating tree monitor eggs. If wild representatives of the *V. prasinus* complex do in fact deposit their eggs in arboreal termite nests as suggested by Greene (1986), a substrate-less, suspended incubation method may yield better results. Surfaces inside a termite nest would conceivably be dry, but relative humidity would be extremely high. However, private keepers have also reported hatching failures in *V. prasinus* when using suspension-based incubation techniques (Anonymous, 2012). Although Engle (2004) reported sweating prior to the successful hatching of *V. keithhornei*, Wesiak (2010) identifies it as a sign of suboptimal conditions. While sweating was not specifically reported, monitor lizard eggs have been shown to lose weight before hatching (e.g. *V. albigularis*;



Fig. 10. Egg tooth on embryo #2. Photographed by Claudia Ewerhardy.



Phillips & Packard, 1994); this phenomenon has been observed in other lizard species as well, including *Tupinambis* (Köhler, 1989).

Based on the available information, the incubation failures experienced in this study are suspected to have been related to excessive substrate moisture levels, especially during the critical, final third of incubation. For future egg incubation, an overall drier substrate (1:1 vermiculite to water ratio instead of 1:2) will be used and the clutch will once again be closely observed by frequent weight measurements. Unfortunately, due to a lack of available data, comparisons between developments in egg weights in this study (Fig. 2) and those from successfully hatched clutches could not be made. The reasons for egg #3's immense growth remain unclear. While frequent measurements and candling could have affected the eggs due to temporary temperature changes, internal pressure changes caused by handling, or light stimuli, measurements were conducted as cautiously as possible and were considered necessary to increase understanding of egg development in tree monitors.

Artificially hatching embryos is a critical procedure. Often enough, such hatchlings do not survive the first few days, especially since the state of development at the time of the forced hatching is not precisely known (Köhler, 1989, 2004; Kroneis, 2012). The surviving offspring in this study proved quite vital, however. In retrospect, force-feeding would most likely not have been necessary at all, as the offspring's body weight varied greatly even after it had begun to accept food on its own and fed daily with gusto. Frequent measurements were conducted as non-invasively as possible, but did require capture and restraint. This contributed to the wariness of the offspring towards the keeper which kept it from becoming tame until recently. Still, no serious effects from handling were observed, and now that the offspring has begun to grow (Fig. 11), measurements will be taken less frequently. Its further development will be closely observed and recorded.

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Fig. 11. Molting juvenile *V. beccarii* at 15 weeks. Photographed by Claudia Ewerhardy.

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# HISTORICAL FACSIMILES

## Early Accounts of Komodo Dragons

It is doubtful that any herpetological discovery of the 20th century was met with the same level of excitement and fascination as the discovery and description of the Komodo dragon *Varanus komodoensis* by Ouwens in 1912. Despite reaching lengths of over three meters, one of the greatest shocks of its discovery was not the impressive size itself, but rather the fact that such a large and conspicuous animal could avoid detection for so long, especially with Southeast Asia and the Indo-Pacific region heavily occupied by several European nations throughout the 19th and early 20th centuries. Since its discovery, *V. komodoensis* has become an important flagship species for reptile conservation and popular attraction in zoos and aquariums, and serves as the basis for various fables and tales in pop culture, including the iconic 1933 monster movie, King Kong (Morton, 2005). Given its popularity and allure as the world's largest living lizard, this issue's historical facsimiles section is dedicated to *V. komodoensis*.

We begin with a reproduction of Ouwens' original 1912 description of *V. komodoensis*. Published in the obscure and long out of print journal *Bulletin du Jardin*

*Botanic Buitenzorg*, most varanid enthusiasts have probably never seen this classic work. Next are two articles from the journal *Treubia* which provide some of the earliest captive accounts of *V. komodoensis* in Indonesian zoos. The first, published in 1938, describes several aspects of its reproductive biology, including reproductive behavior, egg deposition, and embryonic development at the Surabaya Botanical and Zoological Gardens (Tanzer & van Heurn, 1938). The second article documents the world's first successful breeding of *V. komodoensis* at the Batavia Zoo in 1941 (de Jong, 1944), which, as far as it can be determined, also represents the first successful breeding of any varanid lizard in captivity. Interestingly, despite *V. komodoensis* being displayed in western nations since 1929, with eggs laid as early as the 1930s at the Amsterdam and Philadelphia Zoological Gardens (Jones, 1965), it wasn't until 1992 - 51 years after Indonesia's first successful captive breeding of the species that *V. komodoensis* was successfully bred outside of its native Indonesia at the Smithsonian National Zoo in Washington D.C. (Walsh et al., 1993).

-RWM

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Ouwens, P.A. 1912. On a large *Varanus* species from the island of Komodo. Bulletin du Jardin Botanic Buitenzorg 2(6): 1-3.

## On a Large *Varanus* Species from the Island of Komodo

P.A. OUWENS

Through the kind introduction bij Captain W.L. Einthoven, in December 1910, I entered into correspondence with Mr. J.K.H. van Steyn van Hensbroek, 1st Lietenant of Infantry, who served as Civil Administrator at Reo (Island of Flores).

The latter mentioned, that he had received information from the inhabitants of that island, that in the neighborhood of Laboean Badjo, and on the island of Komodo occurred a *Varanus* species of an unusual size. They called the animal "*Boeaja darat*" (land crocodile). His curiosity having been aroused by these reports, he resolved to collect some particulars concerning these animals and to obtain a specimen if possible, as soon as he should be on duty in the island of Komodo.

On his arrival in the island he was provided with the necessary data by Mr. Kock and Mr. Aldegon a.o., members of the pearling fleet, stationed at Komodo, and both of them keen hunters. They informed Mr. van Steyn van Hensbroek, that these animals may even attain a length of 6 to 7 meters. In the beginning of his sojourn in Komodo, Mr. Aldegon shot a few specimens of that size. Since the island has been more frequented, the animals have withdrawn to the mountains. They live, so he says, exclusively on land, where they make great holes under the stones and rocks, in which they always

remain at night. Their feet are fairly long, and in spite of their awkward build, they can move with great rapidity.

In walking, they do not touch the ground, neither with the chest nor with the belly. They walk on the balls of the feet, as may be clearly seen by the callosities on them, as well as by their footprints. The neck is rather long and extraordinarily mobile. The animal can move its head in every direction, and so it can see everything: this is of great use to the creature, as it seems to be remarkably deaf. Mr. Aldegon says, that, if only care is taken, that the animal does not see the hunter, the latter may make as much noise as he pleases, without the animal being aware of his presence. Its deafness is confirmed by the circumstance, that it only goes out in the daytime and never at night. They live either singly or in troops. Their food is exclusively of animal nature.

If Mr. Aldegon shot wild pigs or birds and left them on the ground, they were eaten by the *Boeaja darat*, which sometimes fought desperately for the prey.

The above mentioned notes are according to Mr. van Steyn van Hensbroek.

During the time of his stay in Komodo he was fortunate enough to obtain a specimen 2.20 M long, of which he sent me a photograph (1) and the skin.

He further informed me, that he would try to catch



Plate 1

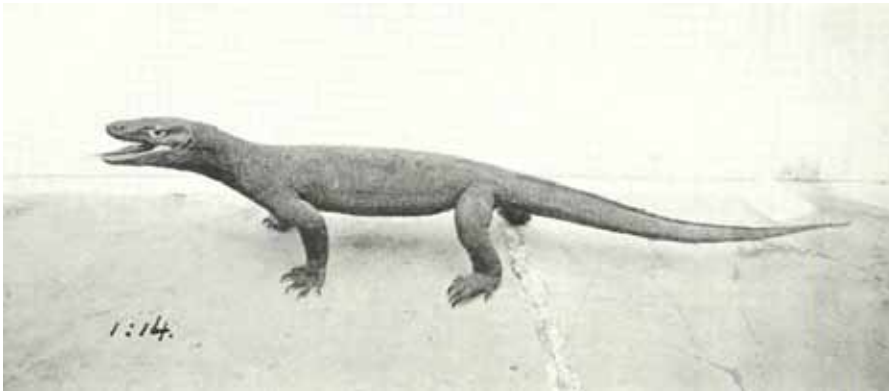


Plate 2

a living animal of larger size, but that this would not be so easy, as the inhabitants will not run the risk, for the animals not only bite, but keep the natives at a respectful distance by powerful blows with their tails.

As it was now established, that in Komodo exists a species of *Varanus* of exceptional dimensions, a native collector of the Zoological Museum here, was sent to Mr. van Steyn van Hensbroek in order to try to obtain further specimens with his assistance. As Mr. van Steyn van Hensbroek was soon transferred to Timor, the collector with the Radja Bitjara (native chief) and the necessary natives and dogs started out alone, with the result that he brought home one animal of 2.90 M, (2) one of 2.35 M, and two very young ones of about 1 M. The two young specimens are still alive.

Finally according to Mr. van Steyn van Hensbroek, another specimen of about 4 M. was shot at Komodo by

Sergeant Beker.

The collector quite confirms the observations of Mr. Aldegon, regarding deafness and other peculiarities.

Experiments made here with the young animals lead to the same conclusion.

Teeth acute, compressed. Snout short, depressed at the tip. Nostril oval, three times as far from the orbit as from the tip of the snout. Digits strong. Tail compressed, keeled above. The caudal keel with a low five-sixtoothed crest. Head- and neck-scales large and very strongly keeled 3). Abdominal scales keeled, in 97 transverse rows. Caudal scales also keeled and in 218 transverse rows. Scales on upper surface smaller than the neckscales and strongly keeled. Dark brown above. Tongue very long and yellow. Tympanum large.

If the animal is indeed a species not yet described, I propose to call it: *Varanus komodoensis*.

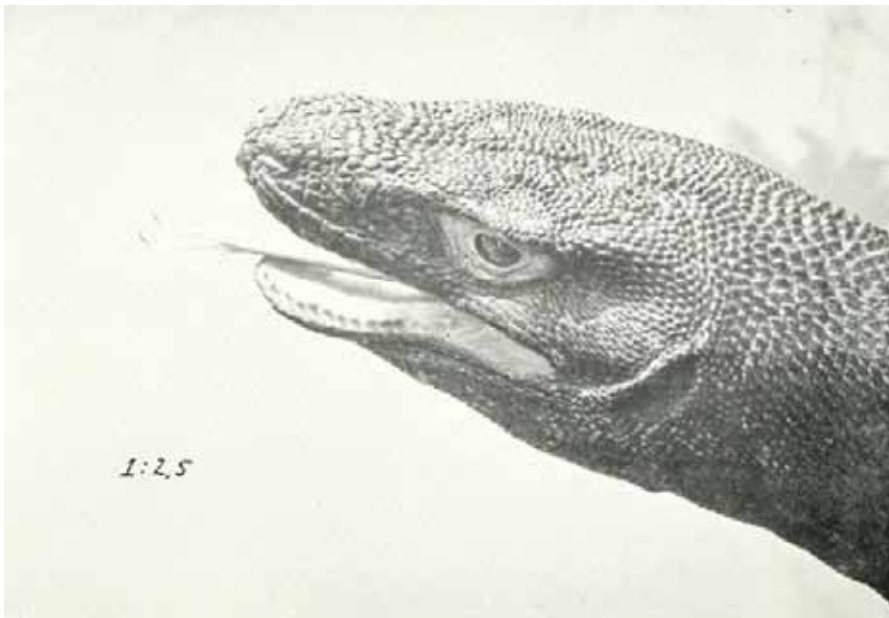


Plate 3



Tanzer, E.L. & W.C. van Heurn. 1938. Observations made by E.L. Tanzer and JHR. W.C. van Heurn with reference to the propagation of *Varanus komodoensis* Ouw. Treubia 16: 365-368.

## Observations Made by E.L. Tänzer and JHR. W.C. van Heurn with References to the Propagation of the *Varanus komodoensis* OUW.

E.L. TÄNZER & W.C. VAN HEURN

In his publication on the *Varanus komodoensis* Ouw. (Nat. Tijdschr. V. Ned. Ind., vol. 97, 1937, p. 193) Dr. J.K. de Jong had to state: "The biology of its propagation, we regret to state, as yet remains a closed book" (1). The Editor of Treubia has now received a report on observations with reference to the mating and the depositing of eggs, sent in by Mr. E.L. Tänzer, made in the Sourabaya Botanical and Zoological Gardens, and in connection therewith also with reference to the results of the examination of a few of these eggs on the part of Jhr. W.C. van Heurn. Both these gentlemen were good enough to put their notes at the disposal of the Editor who has prepared therefrom the following extract.

### *The Animals.*

In the Sourabaya Botanical and Zoological Gardens there are 4 Komodo *Varanus*, as follows:

- 1) a large male (length 2.77 m) presented in 1927 by Mr. H.R. Rookmaaker, at that time Assistant Resident of Flores;
- 2) two specimens, both of them probably males (length 2.40 and 2.50 m, respectively), caught by members of the expedition to Komodo in the spring of 1935; this expedition was headed by Mr. F.F. Schoemakers, at that time the Director of the Gardens, now deceased;
- 3) a small female (length 1.55 m), presented also by Mr. H.R. Rookmaaker in 1927. This female, which has grown little or not at all since that time, deposited eggs twice, once about 6 years ago, and once 4 years ago, in neither instance, however, fertilized.

### *Copulation*

On July 4th, 1937, Mr. Ch. Tänzer witnessed the copulation between the female *Varanus* and one of the two smaller males, in the Gardens since 1935.

Subsequently Mr. G. Hompes, the Manager of the Gardens, witnessed some more copulations, as communicated by him on July 10th, 1937. Such copulations were repeated several times since.

In the course of the copulation the male lies over the female, in the usual manner.

When the urge to copulate had noticeably declined, the female, on July 24, 1937, was transferred to a separate enclosure which was partly shaded.

### *The Depositing of the Eggs (2)*

The floor of the "lying-in room" had been dug out to a depth of from 1-1 ½ metres, and had been filled in with humus and also raised by means of humus.

On one of its sides, at the foot of the hillock, an entrance was made of plates of concrete resting upon concrete corbels. The female, immediately upon being freed within its new enclosure, made use of this entrance by digging itself in there. During the greater part of the day the animal remained in its lair.

It was very rarely seen outside. It took food regularly. So as not to frighten the animal no night observations were made with lamps or lights.

On August 13, 1937, it was discovered that the animal had laid eggs. At that time two eggs had been deposited outside the actual breeding place, at about 1 ½ metres distance from the entrance to the lair. When after two days both eggs were still lying there, one of them was taken away to find out, if possible, whether it had been fecundated. The examinations made by Jhr.

van Heurn proved that the egg was entirely addled, so that it was impossible to establish the development of an embryo.

The other egg had utterly disappeared a couple of days later.

On December 14, 1937, Mr. Hompes saw the animal digging into the side of the hillock. So as not to disturb it he did not further pursue his observation. A couple of hours later he discovered that in the spot where the animal had been digging there was no hole; only the soil showed signs of having been rooted up. Upon further investigation a nest was found here. One of its eggs was extracted to be submitted to a second examination, but so as not to disturb the nest the number of eggs deposited was not ascertained.

### *The Eggs.*

The weight of the egg taken out of this nest on December 14th amounted to 136 grammes. Its colour was evenly white, with a circlet of purplish red spots round one of the poles. The egg shell was parchment-like, and with the circlet of spots mentioned it was softer and less elastic than was the remainder of the shell. The egg was not a perfect ellipsoid, and exhibited a few dents that need not be attributed to decay but could very well have been caused by the evaporation of water. It was opaque. Upon being opened a caked layer of fairly thick substance, of a rose to creamish yellow colour, was found deposited on the inside of the shell, with which layer, surrounded by a disorganized creamish mass, a dead embryo was discovered. Though data are lacking that might suggest the age of the egg, it is nevertheless surmised that it may have developed for two or three months, whilst the embryo probably had died about a month prior to the egg having been opened.

Although, therefore, this egg contained a dead embryo, the nest was not exposed until January 10, 1938, when it proved to contain 14 dessicated egg shells.

In the course of the exposure of this nest a second nest with eggs was discovered close to the first one. It had been made at a greater depth (+- 45 cm) and contained 10 eggs, one of which was empty and dessicated. One of the 9 undamaged eggs was taken away and examined. It weighed 176 grammes. Its colour was a dirty white with an admixture of a somewhat rusty tint. The shell was leathery, the length of the empty egg shell being +- 92 mm, and its transverse section 60 mm. The shell weighed 6 grammes. Upon being opened it was found to contain a living embryo which had not become immersed in the mass of the light yellow yolk, as Jhr. van Heurn had very

often found in the case of snake eggs. The white of the egg was clear and looked somewhat like the fresh white of a hen's egg. The area vasculosa, situated against the egg shell, was less definitely developed than in the case of a hatching birds' eggs, and upon incision exhibited but slight bleeding. As had been done with the preceeding embryo, so also this one was fixed in alcohol-formaline according to Apathy.

On February 18 the nest was once again laid open.

The eight remaining eggs at that time were all of them more or less dented and shriveled.

The examination of these eggs resulted in the following:

Colour of an uneven rustiness with but a few small purple spots. Of the 8 eggs 6 were perforated, one was torn across, and only one had remained intact.

In two of the eggs there was no embryo, their contents being dessicated and disorganized.

The remaining 6 eggs contained embryos in various stages of development, and in various stages of decomposition. The egg that had remained intact contained the largest embryo, measuring 12 cm from snout to anus, and 27 cm from snout to the tip of the tail. The umbilical cord and the membranes of the yolk mass still were almost intact. It must have died after the last but one egg examination on July 10, 1938: the other 5 embryos prior to that time.

Also in these eggs the embryo in all cases was found to lie outside along the yolk mass. The yolks were all of them but little consumed, and in weight and in volume were several times larger than the embryo pertaining to each.

Also these six embryos, like the previous two, were fixed with alcohol-formaline according to Apathy.

The embryonic material, together with 25 egg shells, was placed at the disposal of the Zoological Museum at Buitenzorg, where it is to be submitted to a closer anatomical examination.

### *Final Remarks.*

It is clear that the embryos had died at a comparatively early stage of their development, whilst death had ensued at various periods. In view of the fact that one of the last eight eggs was still undamaged the cause of death cannot have been violence. It is not likely that rats were the cause, nor were any larvae of flies found anywhere, whilst if they had been damaged by the nails of the mother animal the eggs, on account of its great weight, would have been damaged more severely.

The primary cause, therefore, of the failure of these

two nests will most probably have to be looked for in the inappropriate soil. This was too close, and perhaps also too moist, so that there was insufficient air for the embryos to breathe, impairing their development and finally resulting in their death.

Also in other animals in the course of the years too great value has sometimes been attached to the warmth required for incubating in the humus within which the eggs are deposited.

Very often the eggs themselves are warmer than their surroundings, so that the heat seems to emanate rather from the embryo in the course of its development than from the hatching nest material

It is hoped that before long it may again be possible to induce a *Varanus komodoensis* to procreate, in which case there may be a better chance of the outcome being favourable in view of the experience now gained.

de Jong, J.K. 1944. Newly hatched *Varanus komodoensis*. Treubia 18: 143-145.

## Newly Hatched *Varanus komodoensis*

J.K. DE JONG  
(Batavia)

In 1938, Tänzer and van Heurn published a paper (this Journal, 16, p. 365), describing the mating and depositing of the eggs of *Varanus komodoensis* Ouwens in the Soerabaia Zoological Garden. The eggs failed to hatch and only some embryonic material in more or less advanced stages of decomposition, hardly furnishing any basis for further examination, remained.

It was hoped that some following year the garden might show the hatching of the eggs of this giant lizard, but as yet no such thing has happened.

The Zoological Garden in Batavia was more lucky in this respect and on April 15, 1941 two newly hatched Komodo-lizards could be shown to the public.

As the young of *Varanus komodoensis* are as yet unknown to science and as they exhibit an interesting and unexpected colour-pattern, it may be worth while to describe them in some detail here.

The Komodo-lizards kept in the Zoological Garden of Batavia were captured in the hills round the small native village of Kenari on the west-coast of the island of Flores in June 1937. They arrived in Batavia during the first days of the month of July of the same year.

No mating was observed as in the case of the Soerabaia garden, nor any excessive digging from the part of the female.

As soon as the first young Komodo-lizard made its appearance wholly unexpectedly, the direction of the gardens had the kindness to inform me of the event.

Although they were pretty sure that the young animals were really *Varanus komodoensis*, they wanted me to identify the specimens. This was easy enough, the animals showing all the typical features of the adult lizards with only some slight deviations as regards the relative lengths of body and tail.

I wish here to express my thanks to the Direction of the "Vereeniging Planten- en Dierentuin Batavia" for the opportunity they gave me to inspect and measure the young lizards immediately after birth and especially to Mr. W. Koenders for allowing me to reproduce his photograph of a young lizard taken some days after birth.

The measurements given in the following table were taken from the live animals. They are not absolutely accurate for the young lizards objected strongly to being touched by human hands, and by no means we were going to hurt them. They are, however, accurate enough for the purpose of showing the differences with the adult animals, where the tail is only slightly if at all longer than head and body.

	mm	mm
length of head and body	210	200
length of tail	285	280
length of the head	45	44
width of the head	22	22



The animals were very aggressive, quite in contrast to the young of *Varanus salvator* Laurenti. The photo shows one of them in his unfriendly mood, displaying the gular sac in much the same way as do the adults when they meet in the field in the neighborhood of bait.

It is a well known fact that the young specimens of other *Varanus* species are much more brightly coloured than the adult ones, and the same holds true for *Varanus komodoensis*.

In the young the sides of the head are yellowish with a dark smoky horizontal streak running through the eye. There are some blackish vertical bars on the upperlip. The neck is bright yellow or yellowish green, with four or five chevron-shaped black bands on the nape, followed by more black stripes, which reach as far as the shoulder. The forelimbs are black with yellow transverse bands which are broadest near the shoulder. Most of the narrower bands on the lower arm are broken up into yellow dots, covering two or more scales. The hindlimbs are dotted with small whitish specks. The body is dark brown, dotted with numerous ocelli of a dull brick-red colour. These ocelli are arranged in crossbands. This red of the ocelli is of the same hue as the reddish colour that may sometimes be observed on the body of the younger animals.

The tail is banded with alternating narrower and broader transverse bands of a dull yellowish colour. The

narrow bands in the anterior part of the tail are broken up into ocelli. The darker brown interspaces which anteriorly are rather broad become narrower towards the tip of the tail.

Of these bright colours hardly anything remains in the adult animals. In the tails one may observe some indications of the transverse bands, exhibiting darker and lighter areas. I never saw the slightest trace of ocelli on the body but the brown brick-red colour is a rather common feature in the middle sized animals especially when they have just left the water, and are not yet covered with mud or dust. The neck in the younger specimens is always of a lighter colour than the rest of the body, sometimes it even might be called greenish-yellow, but in the smallest specimens I ever saw in the field, measuring about 125 cm in length, there was never any trace of the black chevron stripes on the nape. The sides of the head are usually of a lighter colour, even in the older males and yellow markings round the eyes may even be present in very old males.

If we review the known facts concerning the propagation of *Varanus komodoensis*, we find that the mating season falls in the month of July, and that the eggs are laid in the month of August, both facts established in the Soerbaja Zoological Garden. The eggs hatch in the month of April, as found in the Batavia garden. So the duration of the egg-stage is eight months.

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## Varanid Mortality at the Bronx Zoo and its Implications for Captive Husbandry and Reproductive Management in Zoos

Varanid lizards have been maintained in zoological parks for more than a century, yet few studies to date have attempted to pinpoint significant health issues affecting their management or areas of captive husbandry that are in need of improvement. In an effort to identify and better understand some of the husbandry-related challenges and health issues specifically affecting varanids in zoos, this study examined mortality in 16 species maintained at the Bronx Zoo between 1968 and 2009.

Out of 108 records reviewed, complete necropsy reports were available for 85 individuals. Infection-related processes including bacterial (15.3%), protozoal (12.9%), nematode (9.4%), and fungal (3.5%) infections accounted for the greatest number of deaths (47.1%). Noninfectious diseases including female reproductive disorders (7.1%), neoplasia (7.1%), gout (10.8%), and hemipenial prolapse (1.3%) accounted for 29.4%

of deaths. Multiple disease agents were responsible for 5.9% of deaths, and a cause for death could not be determined for 17.7% of individuals. Reproductive complications accounted for 11.5% of female deaths, but were identified in 23.1% of females. Although not necessarily the cause for death, gout was present in 18.8% of individuals. Differences in mortality between species, genders, and origin (captive-bred vs. wild-caught) were also evaluated.

The results of this study corroborate earlier findings that identify bacterial infections, neoplasia, female reproductive disorders, gout, and endoparasitism as major sources of mortality in captive varanids. In light of these results, we discuss potential etiologies and offer recommendations for improving captive management practices in zoos.

Mendyk, R.W., A.L. Newton & M. Baumer. 2012. A retrospective study of mortality in varanid lizards (Reptilia: Squamata: Varanidae) at the Bronx Zoo: Implications for husbandry and reproductive management in zoos. *Zoo Biology*. (Wiley-Blackwell). DOI: 10.1002/zoo.21043

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*Varanus juxtindicus*. Rennel Island, Solomon Islands. Photographed by **Tony Morris**.



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*Varanus varius*. Manilla, New South Wales. Photographed by **Jon Irvine**.